CHAPTER 4 - AFFECTED ENVIRONMENT

4.1 INTRODUCTION

This chapter presents descriptions of the variety of environmental resources and local features which exist in areas that could be affected by one or more of the water supply alternatives. Some resources or features that are unlikely to affect or be affected by the alternatives (e.g., climate and geology) are described rather briefly while resources or features identified during the scoping process as important issues are described in much more detail. The arrangement of topics and the numbering of sections in this chapter is the same as the arrangement of these topics and section numbers used in Chapter 5 (Environmental Consequences).

4.2 CLIMATE, GEOLOGY, AND SOILS

Climate

Maury, Marshall, Bedford, and adjacent counties in middle Tennessee are affected by warm, humid summers and cool winters. Average precipitation is 53.6 inches per year, with the heaviest rainfall (4.5 to 6 inches per month) occurring in March, April, May, and December (TVA, 1998a). About 50 to 70 percent of precipitation is returned to the atmosphere by evaporation from the land and plants (USGS, 1995). Winds are relatively light, especially in the summer and early fall. Climate statistics, presented in Table 8, characterize temperature, precipitation, snowfall, relative humidity, thunderstorm events, and wind speed in this area. The Lewisburg agricultural experiment station is the most representative weather station for the area, but the information collected there is limited to temperature, precipitation, and snowfall (U.S. Department of Commerce, 1961-1994). For the other three variables in the table, data for the Nashville, Tennessee, and Huntsville, Alabama, National Weather Service stations are provided (U.S. Department of Commerce, 1994b; 1994c). Of the two, Nashville is the more representative station for the study area.

Geology

Most of the area that could be affected be the action alternatives is located within the Central Basin Section of the Interior Low Plateau Physiographic

Table 8. Climate statistics representing the Columbia Project area. Data from U.S. Department of Commerce sources.

Month	Temperature Normals Lewisburg (1961-1990)		Precipitation Normals Lewisburg (1961-1990)		Average Snowfall Lewisburg (1961-1994)		Average Relative Humidity (%) at four selected times of the day (CST) Nashville (1966-1994)				Huntsville (1968-1994)				Average Thunderstorm Days Nashville (1942-1994)	Huntsville (1968-1994)	Average Wind Speed Nashville (1942-1994)		Huntsville (1968-1994)	
	°F	°C	inches	cm	inches	cm	00	06	12	18	00	06	12	18			mph	km/h	mph	km/h
Jan	34.8	1.6	4.49	11.4	2.9	7.4	75	80	63	65	78	82	64	68	1.2	1.1	9.1	14.6	9.3	14.9
Feb	38.5	3.6	4.12	10.5	1.6	4.1	73	80	59	60	75	81	59	61	1.6	2.1	9.3	14.9	9.7	15.6
Mar	47.7	8.7	5.97	15.2	0.5	1.3	71	78	53	54	73	81	56	57	4.0	4.3	9.9	15.9	10.1	16.2
Apr	57.1	13.9	4.67	11.9	T		72	80	51	52	75	83	52	52	5.1	4.7	9.3	14.9	9.3	14.9
May	65.3	18.5	5.66	14.4	0.0		82	86	55	58	83	87	56	60	7.2	7.1	7.6	12.2	8.1	13.0
Jun	73.3	22.9	3.85	9.8	0.0		84	87	55	59	85	88	56	61	8.2	8.5	7.1	11.4	7. 0	11.3
Jul	76.9	24.9	5.19	13.2	0.0		85	89	57	62	87	90	59	65	9.5	10.3	6.5	10.5	6.3	10.1
Aug	76.0	24.4	3.25	8.3	0.0		85	90	57	62	87	91	58	66	7.7	8.2	6.2	10.0	5.9	9.5
Sept	69.7	20.9	3.79	9.6	0.0		85	90	58	64	87	91	59	68	3.6	4.9	6.5	10.5	6.8	10.9
Oct	58.0	14.4	3.81	9.7	0.0		81	86	54	60	83	87	55	65	1.6	2.1	6.8	10.9	7.5	12.1
Nov	48.4	9.1	4.85	12.3	0.5	1.3	77	81	59	64	79	84	58	65	1.7	2.3	8.4	13.5	8.6	13.8
Dec	39.1	3.9	5.05	12.8	0.8	2.0	76	80	63	67	78	82	63	69	1.1	1.1	8.9	14.3	9.3	14.9
Annual	57.1	13.9	54.70	138.9	6.3	16.0	79	84	57	61	81	86	58	63	52.6	56.9	8.0	12.9	8.2	13.2

Province as described by Fenneman (1938). The northwestern and southwestern corners of Maury County and nearly all of Coffee County are located in the western and eastern parts of the Highland Rim (respectively), also sections of the Interior Low Plateau. The Interior Low Plateau is a relatively level area; however, some sections have been substantially eroded. This eroded plateau extends from the Cumberland Plateau (on the east) to the Mississippi embayment of the Coastal Plain Physiographic Province (on the west). The Interior Low Plateau is bordered on the north by the Till Plains section of the Central Lowlands Physiographic Province.

The Central Basin is a plain with an elevation of 550 to 700 feet which is completely surrounded by the Highland Rim. Geologically, this Basin was formed when part of the Highland Rim was pushed up and began to erode faster than the surrounding area. Because this erosion is incomplete, the Central Basin contains knobs and ridges which rise as much as 200 feet above the basin floor.

The rocks of the Central Basin and adjacent parts of the Highland Rim consist of massive, clayey limestones and dolomites, some of which include thin lenses of brown shale. Several different geologic formations are present in different parts of the area (Figure 13). Nearly flat rocky areas with very little soil, commonly called glades, occur throughout the Central Basin. The thick limestone layers often include fractures which may have been eroded and enlarged by the moving water. In some locations, sinkholes or caves of various sizes may exist. Only a few larger caves are known to exist in this area.

Soils

The U.S. Department of Agriculture has conducted surveys of the soils in Maury and Bedford Counties (U.S. Department of Agriculture, 1959; and 1947, respectively). Soil surveys have not been conducted in Marshall and other adjacent counties in the area; however, the general patterns within this part of the Duck River basin are likely to be quite similar.

Soils in both Maury and Bedford counties can be grouped into classes, generally related to streams and terrain. The soils in the bottoms along the Duck River are Huntingdon-Lindside-Armour (Terrace Phases)-Egam soils which are well- to moderately well-drained, silty, loamy soils. These are moderately to highly productive agricultural soils and are suitable for most row

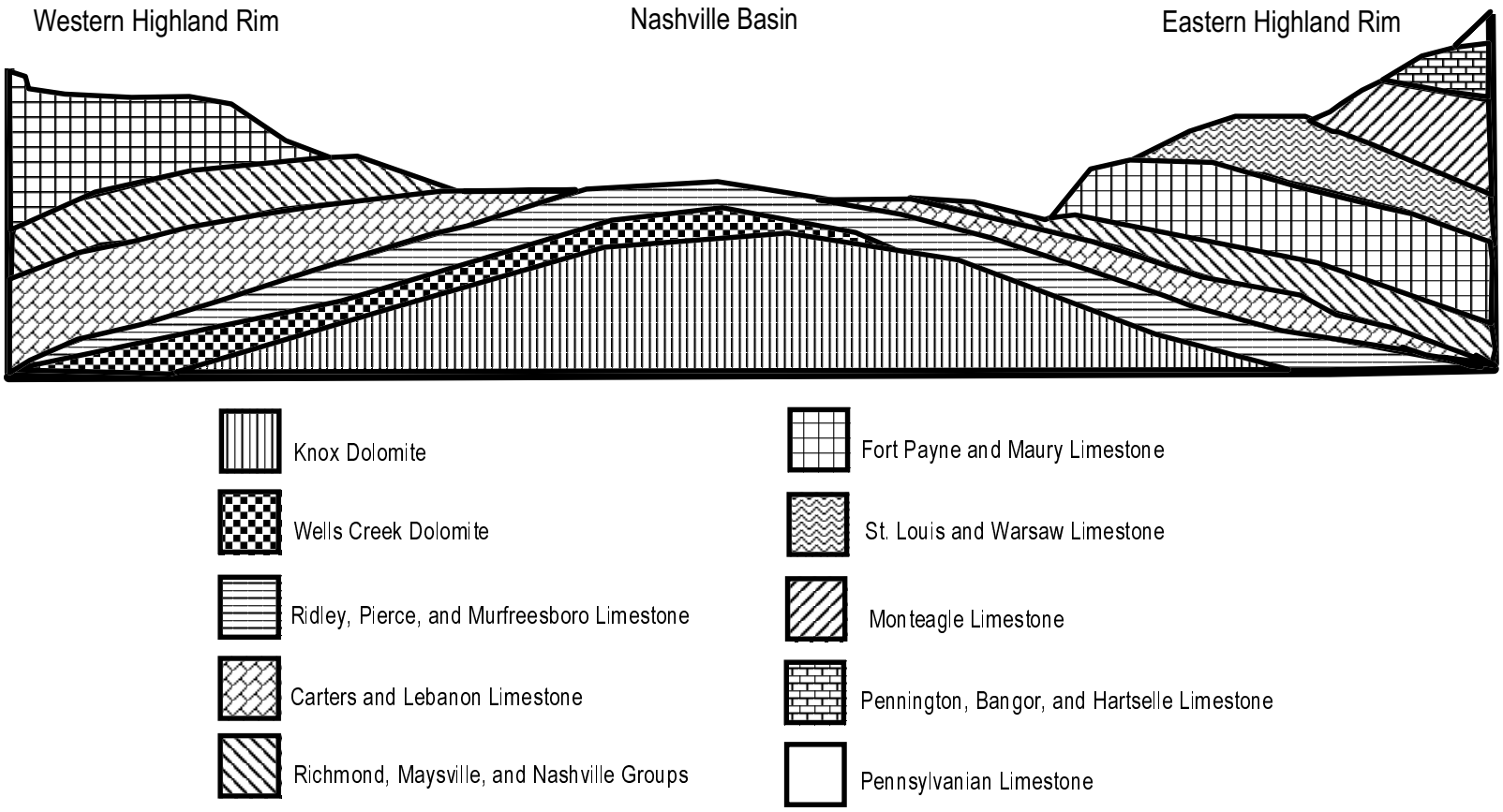

Figure 13. Upper Duck Region, Schematic Geologic Cross Section. Redrawn from Duck River Project Final Environmental Impact Statement figure, April 28, 1972, TVA Office of Health and Environmental Science.

crops. Some Huntingdon and Armour soils are considered prime farmland soils (see Section 4.10).

Scattered along both sides of the river are fairly large pockets of Etowah-Huntingdon (local alluvial phosphatic phases)-Emory soils. They occur in gently sloping areas and are well-drained, moderately deep to deep, silty, loamy soils. These soils are very productive and are suitable for a wide variety of crops and pasture.

Two soil associations cover the majority of the upland areas within the inner Central Basin in the eastern quarter of Maury County. These are the Rockland-Talbott-Hagerstown (Rocky) and the Talbott-Hagerstown-Rockland association. These are similar rocky and thin soils with limestone outcrops and, as the names imply, differ only in the percentage of each soil type present. They are generally covered with red cedars and drought resistant hardwoods. Although some areas are suitable for small grains, the predominant uses of cleared areas are hay and pasture.

The predominate soils of the east-central part of Maury County are of the Inman-Culleoka-Hicks-Maury (coarse phases) association. These soils are acidic, high in phosphorus, and moderately low in other plant nutrients. They occupy sloping to steep parts of ridges of the outer Central Basin and extend into the lower lying inner Central Basin.

The Braxton-Maury-Armour association covers most of the central portion of Maury County. These soils are deep, well-drained, productive, high in phosphorus, organic matter, and plant nutrients. They occur within the outer Central Basin. Many parts of this area have been commercially mined for phosphate, particularly near Columbia and Mount Pleasant, TN.

The predominate soils surrounding the Braxton-Maury-Armour area are of the Dellrose-Frankstone-Mimosa (cherty) association. These soils occupy cherty knobs, steep slopes, and narrow cherty valleys of the outer Central Basin. They are acid, medium to high in phosphorus, and medium to low in other plant nutrients. Most of these soils have moderate to rapid drainage, although the lower subsoil of the Mimosa soils are more clayey and less permeable.

The Bodine-Mountview (shallow phases) -Pace and Mountview-Dickson associations occupy the Highland Rim area of the northwestern and

southwestern portions of Maury County. These soils are low in lime, natural fertility, and moisture-supplying capacity. They are generally shallow and cherty.

Upland soils predominate in Bedford County. They are characterized by the Highland Rim escarpment soil association, the outer Central Basin soil association, and the inner Central Basin soil association. Colluvial lands cover the smallest portion of the county. Soils of the terraces are mostly weathered limestones. Bottomland soils are derived from recently deposited alluvial materials largely washed from soils underlain by limestone. Generally, bottomland soils are medium acid; Central Basin upland soils are medium to strongly acid; and soils of the Highland Rim escarpment are strongly to very strongly acid.

4.3 GROUND WATER

As indicated in Section 4.2, this part of the Duck River basin receives an average of 53.6 inches of precipitation per year. Information presented in Section 4.4 indicates that runoff in this area averages from 20 to 30 inches per year. At least some of the rest of the rain and snow moves down through soil and rock and becomes part of the ground water. Because rain water is slightly acidic, as it moves into the ground it dissolves the limestone and other carbonate rocks along existing cracks and layers. Springs are common in the outer Central Basin and ground water makes up an important part of the low flow in the streams in this part of the watershed.

The geology of the groundwater system in central Tennessee is relatively well defined. Most of the area is underlain by carbonate rocks, primarily limestone with some dolomite. Some shale zones exist in these rocks, as well as phosphate-rich layers and several thin clayey beds. Shale and clay beds can block or redirect the movement of water in the bedrock. Most of the water in limestone and dolomite rocks is stored and moves through solution fractures. The amount of space water could occupy in these beds is estimated to be less than 0.5 percent of total rock volume (USGS, 1995). The flow system is generally limited to the top 300 feet or less below the ground surface (USGS, 1986). In general, the number of connected cracks and spaces through which water could move decreases with depth into the ground.

The principal water-bearing rocks underlying this area include the Ridley, Lebanon, and Carters limestone formations (Figure 13). The Ridley limestone is considered a local aquifer which generally produces low well yields. The Lebanon limestone also is considered a local aquifer, but shale zones can restrict ground water movement in this formation. Water yields from the Carters limestone are highly variable. Although the formation generally provides low yields (less than 5 gpm) to domestic wells, yields in excess of 100 gpm have been encountered (USGS, 1986).

Ground water is used throughout the area as a source for domestic and farm use. Present usage is approximately 6,300 cubic meters per day (1.66 mgd), which supplies about 7,900 people (TVA, 1998a). Data furnished by the Tennessee Division of Water Supply based on drillers' records for the three-county area are summarized in Table 9. A few cautionary notes are in order to put these data into perspective:

- All information has been supplied by individual well drillers without any independent verification.
- Many of the wells were installed over 30 years ago. It is unknown how many of these wells remain in operation.
- Reported results reflect conditions at the time of installation. Conditions, particularly related to well yield, can change over time.

The information summarized in Table 9, indicates that well drilling results are relatively similar in all three counties. Average well depth is shallowest in Bedford County (165 feet) and deepest in Maury County (342 feet). Average well yield (11 to 14 gpm) is very similar in all three counties. In all three counties, between one and two percent of the wells (about which the yield is known) have been reported to produce 100 gpm or more (0.1 mgd), and fewer than one-tenth of one percent produce 500 gpm or more (0.7 mgd). Between 10 and 20 percent of the documented wells (about which the yield is known) produced less than one gpm. Seventy percent of all wells were reported to be used for domestic water supply and three percent were listed to be used for municipal, community, or multi-family water supplies. While previous investigations have identified several sites within the area with potential for additional ground water development (USGS, 1993), even the largest reported yields from wells in these three counties (0.7 mgd) suggest there is little

likelihood of drilling individual wells that could provide enough ground water to supply large communities.

Table 9. Summary of drill records for water wells in Maury, Marshall, and Bedford Counties. Most values in the table are averages, with minimum and maximum values presented in parentheses. (Tennessee Division of Water Supply unpublished data)

Statistics	**Maury County**	**Marshall County**	**Bedford County**
Number of well records	2,095	2,364	1,896
Average Well Depth (feet)	342 (21 - 6400)	237 (5 - 1400)	165 (0 - 1500)
Average Depth to Water Bearing Zone (feet)	267 (0 - 1630)	163 (0 - 1340)	115 (0 - 1175)
Average Yield (gallons per minute - gpm)	11 (0 - 500)	11 (0 - 406)	14 (0 - 500)
Wells yielding less than 1 gpm (unknowns excluded)	173 (10.4 %)	441 (21.6 %)	336 (20.5 %)
Wells yielding 100 gpm or more (unknowns excluded)	27 (1.6 %)	36 (1.2 %)	32 (2.0 %)
Wells yielding 500 gpm or more (unknowns excluded)	2 (0.1 %)	0	2 (0.1 %)

Very little information is available on the quality of ground water in the region. Because the groundwater table tends to be close to ground surface throughout much of the area, generally with little soil cover, groundwater quality tends to resemble surface water quality (personal communication Gordon Corruthers, TDEC Groundwater Management Section, 1999). Surface runoff moves through cracks or solution features into the shallow aquifers.

Ground water in the region tends to be highly mineralized, possibly due to the presence of soluble salts in the limestone. The USGS measured hardness levels (in ppm of $CaCO_3$) in the Lebanon limestone from locations throughout this project area (USGS, 1936). Results were from 310 to greater than 500 ppm in Maury County, from 20 to greater than 600 ppm in Marshall County,

and from 10 to 320 ppm in Bedford County. In a later study (USGS, 1986), water having total dissolved solids levels greater than 10,000 mg/L was found in the same formation within several miles of water with concentrations less than 500 mg/L. In addition to hardness, high levels of hydrogen sulfide have been found in many wells. This indicates that the quality of ground water within the project area can vary from location to location.

More recent data are available from Bedford County (Roman-Mas, et al., 1991). Water samples from 89 wells were analyzed for pH, fecal coliform and streptococcus bacteria, nitrate, chloride, sulfate and specific conductance. Most pH values were in the neutral range (6.5 - 7.5), bacterial levels ranged from less than 1 to "too numerous to count", nitrate levels ranged from less than 1 to 26.1 mg/L (with most values less than 5 mg/L), chloride levels ranged from 1.5 to 75.8 mg/L, sulfate levels from less than 2 to 1,697 mg/L (with most values less than 50 mg/L), and specific conductance levels (an indirect measure of dissolved solids) ranged from 12 to 2550 µS/cm. This information adds to the idea that there is considerable variation in the quality of ground water in the area.

Groundwater quality data available from the state are very generalized, and wells are described based on substances which can be found in a water sample, such as lime, iron, sulfur, salt, oil, gas, or "other." In addition, the water quality is listed as bad, fair, or good. The most common substances found in ground water in Maury County were either hydrogen sulfide or something that fell into the "other" category. Hydrogen sulfide was found in many wells across the county and in neighboring counties, and was generally independent of well depth (Tennessee Division of Water Supply, unpublished data).

Much of the land in the area contains sinkholes which provide avenues of direct groundwater recharge. Sinkholes also sometimes are used as disposal sites for trash and other wastes. Material dumped or allowed to flow into sinkholes can contaminate ground water and any surface water into which it flows. The amount of present dumping into sinkholes in this part of the Duck River basin is unknown and no information is available about any contamination of ground water which might be occurring from sinkhole sources.

To summarize, in this project area ground water is used predominantly for individual home and agricultural purposes. Most wells provide low yields, generally less than 10 gpm, and very few wells produce more than 20 gpm. In addition, the quality of ground water varies throughout the area, at times including total dissolved solids, bacteria, and hydrogen sulfide. While sufficient ground water seems to be present to supply individual residences, there is very little likelihood of drilling wells that could produce enough high quality ground water to supply large communities.

4.4 SURFACE WATER

The surface water resources involved in this evaluation include the upper Duck River watershed and a small part of the Elk River watershed. The Duck River watershed upstream from the Hickman/Maury county line includes an area of approximately 1,700 square miles. Much of this watershed consists of small streams that drain directly into the Duck River; however, the basin does include five tributaries that each drain 100 square miles or more (Garrison Fork [130 square miles], Big Bigby Creek [129], Big Rock Creek [121], Rutherford Creek [116], and Fountain Creek [103]). Normandy Reservoir is the only large impoundment in the watershed [3,230 acres at full pool); however, at least four run-of-the-river dams still impound some water on the mainstem (from downstream: Columbia City Dam, Lillard Mill Dam, Shelbyville Dam, and Courtner's Mill Dam).

After Normandy Reservoir was completed in 1976, the average annual flow in the Duck River has been 843 cfs at Shelbyville and 2155 cfs at Columbia. TVA operates Normandy Dam to provide a continuous minimum flow of 40 cfs immediately downstream from the dam, and 155 cfs of minimum flow at Shelbyville. The 40 cfs of minimum flow downstream from Normandy Dam helps maintain aquatic life in the upper part of the river. The 155 cfs at Shelbyville maintains water quality below the Shelbyville wastewater discharge. As indicated in Section 2.2, Normandy Reservoir has sufficient storage to provide up to an additional 10 cfs of flow to meet water supply needs at Shelbyville. During drought conditions, the water released from Normandy Dam is essentially the only streamflow available in the Duck River to maintain aquatic life and meet water supply and recreational uses. During drought conditions, all but one of the tributary streams between Shelbyville and

Columbia cease to flow and water withdrawals and evaporative losses result in a reduction in streamflow in the 90-mile reach (TVA, 1998a).

The Duck River is considered a warmwater stream except for the 4.6 mile reach just downstream from Normandy Dam which is maintained as a coldwater reach. Dissolved oxygen concentrations in the river are normally 5.0 mg/L or higher, especially upstream from Columbia. Downstream from about Duck River Mile 160, the slope of the river becomes very flat (1.3 feet per mile) and the river is very sluggish. During dry months, natural oxygen replenishment is low in this reach and the combination of high sediment oxygen demand and extensive algal growth reduce dissolved oxygen levels, particularly in long pools.

The parts of the Elk River watershed involved in this evaluation include two embayments of Tims Ford Reservoir and an adjacent reach of East Fork Mulberry Creek. Tims Ford Dam, located at Elk River Mile 133.3, forms a 10,600 acre reservoir that receives water from an area of 529 square miles. The two larger embayments on the northwestern edge of this reservoir, Lost Creek and Hurricane Creek embayments, are separated by Chestnut Ridge. The Jack Daniel Distillery and Lynchburg, Tennessee, operate a joint water intake on the Lost Creek embayment of Tims Ford Reservoir. East Fork Mulberry Creek runs along State Route 55 northeast of Lynchburg, and drains approximately 17 square miles of area just west of the Lost Creek and Hurricane Creek basins. The East Fork flows southwest into Mulberry Creek, which empties into the Elk River near Fayetteville (at River Mile 101).

Water Use

As indicated in Chapter 2, the Duck River is the most important water source for people living in this area. Municipal water intakes are located at Duck River Miles 133.9 (Columbia), 202.4 (Bedford County), 221.9 (Shelbyville), and 255.0 (Duck River Utility Commission) (see Figure 2).

The Duck River also receives most of the discharge from municipal wastewater treatment systems in the area. Wastewater discharges on the river are located at Duck River Miles 127.2 (Columbia), 221.3 (Shelbyville), and 268.5 (Manchester). In addition, the Spring Hill wastewater is discharged into Rutherford Creek 19 miles upstream from its mouth at Duck River Mile 130.4, and the Lewisburg wastewater is discharged into Big Rock Creek 16 miles upstream from its mouth at Duck River Mile 180.4. The only operating

industrial wastewater discharge in the area is located on Big Bigby Creek about 15 miles above its confluence with the Duck River at River Mile 109.2. Several organic and inorganic chemicals regulated under the Safe Drinking Water Act as primary drinking water contaminants are present in the industrial effluent. The company provides a high treatment level for its wastewater, including carbon absorption, to remove organics. The volume of wastewater is small (0.13 cfs) in comparison with the low flow of the creek (3.6 cfs) and the treatment protects the use of Big Bigby Creek for water supply.

As more and more water is withdrawn from the Duck River, the amount of water available for assimilation of treated wastewater is reduced and water supply and waste assimilation actually begin to compete with each other. Furthermore, instream flow needs to maintain recreation and aquatic life also are in competition for the limited remaining water. In recognition of the need to balance all of these uses, TDEC has determined that future water withdrawal at Columbia should not reduce the one-day average flow in the Duck River below 100 cfs (TVA, 1998a).

Classified Uses

TDEC has identified beneficial uses for all surface waters in the state of Tennessee and has established water quality criteria which specify the minimum level of quality necessary to support each use. Nearly all of the Duck River from River Mile 71.5 upstream to its origin has been classified for the following uses: domestic water supply, industrial water supply, fish and aquatic life, recreation, irrigation, and livestock watering and wildlife. Two of the three exceptions along the river are short reaches just downstream from the municipal wastewater discharges at Columbia and Shelbyville. The domestic water supply use classification was excluded in these areas because TDEC previously considered stream reaches immediately downstream from municipal wastewater discharges to be unsuitable for domestic water supply withdrawal. TDEC no longer considers the first five miles of stream reach downstream from a wastewater discharge to be unsuitable for domestic water supply use and would reclassify the reach to protect that use if requested to do so. The third exception is the 4.6-mile reach of the Duck River just downstream from Normandy Dam. This reach is classified as a trout stream and is expected to have higher dissolved oxygen levels and a lower maximum temperature than water classified for warmwater fish and aquatic life.

All tributary streams flowing into the Duck River within this project area have been classified for the following uses: fish and aquatic life, recreation, irrigation, and livestock watering and wildlife. In addition, six of the larger tributaries (Garrison Fork, Big Rock Creek, Rutherford Creek, Little Bigby Creek, Big Bigby Creek, and Catheys Creek) have been classified for domestic and industrial water supply use. Although these streams are classified for these uses, the mainstem Duck River is the only stream in this part of the watershed that is presently being used as a domestic or industrial water supply source. The classification means that the quality of water in these streams should be maintained at a level capable of supporting all of the identified uses, in this case including domestic and industrial water supply.

As a whole, Tims Ford Reservoir is classified for the following uses: domestic water supply, industrial water supply, fish and aquatic life, recreation, irrigation, and livestock watering and wildlife. The specific parts of Tims Ford Reservoir in the Hurricane Creek and Lost Creek embayments are classified for the following uses: fish and aquatic life, recreation, irrigation, and livestock watering and wildlife. East Fork Mulberry Creek is classified for industrial water supply, fish and aquatic life, recreation, irrigation, and livestock watering and wildlife.

Water Quality - Upper Duck River Watershed

TDEC regularly evaluates water quality conditions in streams to determine if conditions are capable of supporting the classified uses. In the 1998 assessment (TDEC,1998), several stream reaches in the upper Duck River watershed were identified as having some degree of use impairment. These stream reaches, their recent ratings, and the listed reasons why water uses are not being fully met are presented in Table 10. All of the other reaches of the Duck River and its tributaries in this project area were found to be fully supporting their classified uses.

Although several tributary streams in this project area only partially support their classified uses, these effects are typically confined to the tributaries themselves and have little impact on the mainstem Duck River. Like many other parts of Tennessee, soil erosion along roadsides, cropland, and denuded stream banks cause widespread fluctuations in turbidity, suspended solids, and other water quality indicators in this watershed. Soil erosion in several of the tributaries also contributes to the high turbidity levels observed in the river following major runoff events.

Table 10. Stream segments in the upper Duck River watershed that were not supporting their classified uses in 1998 (TDEC, 1998).

Stream Segment	Rating	Apparent Cause
Coffee County		
Duck River mainstem below the mouth of the Little Duck River	Not Supporting	bacteria contamination from the Manchester municipal wastewater collection system, urban runoff
Bedford County		
Duck River below Normandy Dam to (the upper) Flat Creek	Partially Supporting	non-point sources, high levels of iron and manganese in releases from Normandy Dam
Doddy Creek	Partially Supporting	agricultural non-point sources
Wartace Creek	Partially Supporting	agricultural non-point sources, Bell Buckle municipal wastewater treatment plant discharge
Bell Buckle Creek	Partially Supporting	agricultural non-point sources, Bell Buckle municipal wastewater treatment plant discharge
Thompson Creek (including Bennett Branch and Anderton Branch)	Partially Supporting	agricultural non-point sources, landfill leachate
Fall Creek	Partially Supporting	agricultural non-point sources
North Fork Creek	Partially Supporting	agricultural non-point sources
Alexander Creek	Partially Supporting	agricultural non-point sources
Weakley Creek	Partially Supporting	agricultural non-point sources
Clem Creek	Partially Supporting	agricultural non-point sources
Spring Creek	Partially Supporting	agricultural non-point sources
Caney Creek	Partially Supporting	agricultural non-point sources
Marshall County		
Big Rock Creek	Partially Supporting	Lewisburg municipal wastewater treatment plant, urban runoff
Maury County		
Fountain Creek (including Silver and Globe creeks)	Partially Supporting	agricultural non-point sources
Catheys Creek (including Curry Branch)	Partially Supporting	agricultural non-point sources
unnamed tributary to Little Bigby Creek	Not Supporting	urban non-point sources from Columbia
Lytle Creek	Partially Supporting	industrial point sources
unnamed tributary to Lytle Creek	Not Supporting	industrial point sources
Rutherford Creek	Partially Supporting	industrial point sources, mining
Sugar Creek	Not Supporting	landfills, an industrial point source, and mining

Nitrogen and phosphorus levels in the upper Duck River watershed, consistently in the upper range of values observed in Tennessee River watersheds (TVA, 1984), strongly suggest contributions from non-point sources. Total iron and total manganese concentrations also are high in comparison to other watersheds in the Tennessee Valley (Parr, 1991). Most of the iron and manganese is in a relatively insoluble form and can be easily removed from drinking water by conventional treatment processes. High levels of bacteria in tributary streams are a major source of bacteria observed in the Duck River after rainfall events.

Organic compounds from point and non-point sources, combined with inputs from natural sources such as tree leaves and algae, can cause high levels of organic material to be present periodically in the streams within the upper Duck River watershed. When water suppliers add chlorine to the water as part of their treatment procedures, the chlorine reacts with the organic material to form disinfection byproducts such as trihalomethanes and haloacetic acids. New, more stringent standards resulting from the 1996 amendments to the Safe Drinking Water Act are scheduled to go into effect in December 2001 for larger water treatment systems and in December 2003 for smaller systems. Some water systems which use the Duck River as a water source may not be able to reach the new standards without modifying their present treatment methods. Two water systems have already been identified by TDEC as not being able to meet the new standards using their present treatment methods.

On a more site-specific basis, starting at the upstream end of the watershed, water quality impacts have been identified in the Little Duck River and Duck River as a result of sewage collection system problems at Manchester. The state of Tennessee advises against water contact in the Little Duck and Duck rivers in the vicinity of Old Stone Fork State Park.

TVA has monitored the ecological health of Normandy Reservoir several times since 1993 (TVA, 1998b). The ecological health of this reservoir has consistently been rated fair each time it has been evaluated, largely because of severe dissolved oxygen depletion and poor rating for the benthic community. Typically from late May through October, the dissolved oxygen concentrations in the reservoir are below 1mg/L in all but the upper 15 feet of the water column. Normandy Reservoir has one of the worst dissolved oxygen depletion problems in the TVA reservoir system. The absence of dissolved oxygen also causes an increase in dissolved iron and manganese levels in the deeper water

of Normandy Reservoir and in the water released from the dam. High concentrations of iron and manganese also make water in the lower part of the reservoir less desirable for water supply withdrawal. In 1998, the average summer chlorophyll-a concentration was 12.6 ug/L which was higher than in any of the other previous year and indicates a higher degree of algae production than in the past (TVA, 1998b).

Bacteriological sampling conducted in the summer of 1999 at two Normandy Reservoir recreation areas indicated some contamination at both sites. At the Barton Springs Public Use Area, two samples collected in June exceeded the state of Tennessee water quality recreation individual sample criterion (1,000/100mL fecal coliform). This criterion also was exceeded once in June at the Cedar Point Public Use Area. The other Tennessee water quality recreational site bacterial criterion (geometric mean value of 200/100mL of 10 samples taken over a 30-day period) was not exceeded at either of these sites. These occasional episodes of bacterial contamination may be associated with the large number of waterfowl that congregate around both of these public use areas.

During summer and fall, the releases from Normandy Reservoir produce high levels of iron and manganese in the Duck River just downstream from the dam. Iron and manganese coatings on river rock extend as far downstream as Duck River Mile 239.9 (Tennessee Technological University, 1983). Iron and manganese impact the use of the Duck River for water supply and aquatic life from Normandy Dam to the confluence of Garrison Fork (Duck River Mile 239.6). In 1993, bacteriological testing by TVA at four locations between Normandy Dam and Shelbyville (Duck River Mile 221.4) showed that fecal coliform bacteria levels exceeded the Tennessee water quality criterion for recreational use. Bacterial levels were highest after rainfall, suggesting non-point source contributions. As indicated in Table 10, TDEC has determined that the Duck River from River Mile 236.9 to 219.1 is only partially supporting its recreation and aquatic life use classifications due to bacteria and siltation from agricultural and urban non-point sources.

Agricultural activities are extensive in the upper Duck River watershed, primarily in Marshall and Bedford Counties. Runoff from dairy and livestock operations, along with soil erosion from roadsides, cropland, and denuded stream banks, are the principal non-point sources in this part of the watershed. These sources cause wide fluctuations in water quality indicators

such as turbidity, suspended solids, and fecal coliform bacteria. Residential development in the watershed area also has been linked to bacteria contamination in the surface waters. The substantial bacterial contamination observed in Fall Creek and North Fork Creek (Table 10) appear to be the result of a combination of agricultural and septic system non-point sources. Bacteriological sampling conducted by TVA during the summer of 1995 indicated that similar increases occur in eastern Maury County (TVA, 1999). Those data also indicated that almost every increase in bacterial counts in the water could be traced to a rainfall event upstream from the sampling location. Reductions in bacterial numbers to low levels following one or two days of dry weather suggested that non-point sources were responsible for the high levels.

Big Rock Creek is impacted periodically by the Lewisburg wastewater discharge. During dry months, the very low flow in Big Rock Creek provides insufficient initial dilution for the assimilation of the municipal wastewater discharge. This results in low dissolved oxygen concentrations and organic enrichment impacts downstream from the treatment plant; however, these impacts do not extend into the Duck River downstream from the mouth of Big Rock Creek.

As indicated in Table 10, TDEC has determined that water quality criteria are being exceeded in the Fountain Creek watershed, apparently from agricultural non-point sources. During the summer of 1998, TVA measured water quality in Fountain Creek and at six tributary sites. The data collected during this study are presented in Appendix A. Results from that study indicated that fecal coliform bacteria at two sites on Fountain Creek exceeded the Tennessee water quality criterion of 1,000/100mL in an individual sample on three different sampling dates. The same criterion was exceeded at a site on South Fork on two sampling dates. Other sampling locations showed elevated levels of bacteria suggesting impacts from agricultural non-point sources. The study was conducted during an extended dry period in August-November so the observed bacteria levels were probably lower than what would have been observed during or immediately following a rainfall event.

TDEC monitors water quality at Duck River Mile 113.9 in Maury County on a quarterly basis. Results since 1990 show that fecal coliform levels have periodically exceeded 1,000/100mL during and immediately following major rainfall events. These high bacterial levels probably are related to the large number of farm animals present in the watershed and their accessibility to the

river system. High levels of fecal coliform bacteria indicate the potential for disease-causing organisms to be present and are a concern for recreation and water supply uses.

Water Quality - Tims Ford Reservoir Area

TDEC has determined that all streams in the Elk River watershed area covered by this analysis, as well as Tims Ford Reservoir, are fully supporting designated uses. Bacteriological sampling in June 1999 at four recreation sites on Tims Ford Reservoir showed all sites met the Tennessee water quality criteria for water contact recreation use (TVA, 1999).

TVA has monitored the ecological health of Tims Ford Reservoir several times since 1992 (TVA, 1998b). The resulting ecological health ratings for Tims Ford Reservoir have declined from fair in 1992, 1993, 1994 and 1995 to poor in 1996 and 1998. Recent poor ratings are the result of low concentrations of dissolved oxygen during the months of June through October, poor benthic community results, and increased chlorophyll-a levels over previous years. Dissolved oxygen levels were less than 2 mg/L throughout most of the lower water column and at or near zero on the bottom of the reservoir from July to October. The consistent low dissolved oxygen levels at the bottom of the reservoir help explain the poor condition of the aquatic organisms living there. Low concentrations of dissolved oxygen would extend into deeper portions of the Hurricane Creek and Lost Creek embayments of Tims Ford Reservoir. Also, increased levels of dissolved iron and manganese would be expected to be associated with low concentrations of dissolved oxygen.

4.5 AQUATIC LIFE

Information presented in the Columbia Land Use EIS (TVA, 1999) indicates that the Duck River supports some of the most species-rich aquatic communities in North America. Most recent surveys of aquatic life conducted in this watershed, however, have focused on the middle reach of the Duck River, the part that would have been affected by completion of the Columbia Reservoir Project. The four action alternatives included in this EIS could affect other parts of the mainstem Duck River, ranging from near the Hickman County Line (River Mile 100) upstream to Normandy Reservoir (as far upstream as River Mile 265). In addition, these alternatives could affect some Duck River tributary streams and, under the Tims Ford Pipeline Alternative, small parts of the upper Elk River watershed.

The following discussion covers the aquatic life present in this study area but uses a number of techniques to abbreviate and clarify the presentation for most general readers. The discussion is divided into two major parts: the Duck River and other "big water" habitats, and Fountain Creek and the other tributary streams. Within each of these parts, individual paragraphs describe what is known about the major groups of aquatic plants and animals that are present. This text is accompanied by just two tables which summarize the data; however, all of the supporting lists of species are presented in Appendix B. The intent of this section is to describe the types of aquatic habitats that are present in this study area and to indicate the diversity of species that occur in each of them.

River and Reservoir Habitats

The Duck River is the major aquatic habitat within this study area; however, various parts of the river have different habitat characteristics and support different types of aquatic communities. For this discussion, the Duck River is considered to consist of three parts: a more downstream reach, a middle reach, and an upstream reach. The downstream reach included in this evaluation extends from near the Hickman/Maury County line (about River Mile 100) upstream through the City of Columbia and the pool of the Columbia City Dam (to approximately River Mile 135). As indicated in Section 4.4, this 35-mile reach of the river has a rather low gradient and consists of long pools and well-defined runs or riffles. Near its upstream end, this river reach also receives wastewater and other discharges from the developed areas around Columbia.

The middle reach of the Duck River included in this evaluation extends from the upstream end of the Columbia City impoundment (around River Mile 136) upstream to Lillard Mill Dam (River Mile 179). This 44-mile river reach consists of somewhat shorter pools and a large number of well-defined riffles, runs, and island complexes. At its upstream end, Lillard Mill Dam forms a barrier to upstream fish movement (except under high flow conditions). Much of this reach meanders through the Columbia Project lands, relatively little of which has been cultivated or affected by extensive human development since most of the land was acquired about 20 years ago.

The upstream of these Duck River reaches extends from above Lillard Mill Dam (about River Mile 180) upstream to Normandy Dam (River Mile 249). The physical habitat in this 70-mile river reach is similar to the middle reach; however, the flow regime and temperature of the water are both affected by releases from Normandy Dam (See Section 4.3). This reach also receives wastewater and other discharges from the area around Shelbyville.

Two additional habitats are included in this part of the discussion, primarily out of convenience. Normandy Reservoir is an impoundment on the Duck River located at River Mile 249. As indicated in Sections 1.2 and 4.4, Normandy Dam was closed in 1976, and forms a 3,230-acre impoundment. At the summer pool level, this reservoir is 87 feet deep; however, the level is drawn down 11 feet during the winter.

Tims Ford Reservoir is an impoundment on the Elk River at River Mile 133. As indicated in Section 4.4, this reservoir is located in Moore County, just south of Bedford County and the upstream part of the Duck River basin. Tims Ford Dam, which was closed in 1970, forms a 10,600-acre reservoir at summer pool and is 130 feet deep adjacent to the dam. The winter drawdown is 23 feet.

Table 11 presents a summary of the numbers of species or other taxonomic levels that have been encountered in each of these five river or reservoir reaches during the last 30 years. As indicated in this table, between 44 and 436 different forms of aquatic life have been identified from these areas. The following paragraphs address several of the major groups of plants and animals that are included.

Table 11. Summary of numbers of aquatic species known from three reaches of the Duck River, Normandy Reservoir, and Tims Ford Reservoir. Supporting data and references are presented in Appendix B.

Plant and Animal Groups	**DRM 100 - 135**	**DRM 136-179**	**DRM 180 - 249**	**Normandy Reservoir**	**Tims Ford Reservoir**
Plankton	NS	123	118	NS	NS
Plants	NS	10	12	NS	NS
Insects	NS	142	81	3	7
Other Invertebrates	NS	27	17	5	5
Mollusks	22+	54	23	1+	NS
Fish	56	80	72	35	36
Totals	**78+**	**436**	**323**	**44+**	**48+**

NS - Community not sampled in this reach

Plankton and Periphyton

The small (generally microscopic) plants and animals which live floating in the water make up the plankton community. Some of these same microscopic species or genera also live in the periphyton, the thin layer of living things that forms on rocks, twigs, and other material in the water. Between 1979 and 1983, TVA staff conducted a great deal of biological work in the Duck River (and elsewhere) as part of the Cumberlandian Mollusk Conservation Program (CMCP, see Section 1.2). Two of 15 sites examined in detail as part of the CMCP work were located in the Columbia Reservoir area (Sowell Ford, River Mile 156; and Lillard Mill, River Mile 179). Two other CMCP sites (Halls Mill, River Mile 202; and Dement Bridge, River Mile 243) were located between the proposed reservoir area and Normandy Dam. During the CMCP evaluation, plankton and periphyton samples were collected monthly at the four Duck River CMCP sites from July through September 1980, and from April and June through September 1981 (Wade and Webb, 1986). No detailed plankton or periphyton identification data are available from the Duck River downstream of Columbia or in either Normandy or Tims Ford reservoirs.

The names of the various species or genera found in these two river reaches are presented in Appendix B (Tables B-1 and B-2) and the numbers of species are summarized in Table 11. With regard to the overall number of species or genera present, about the same number of plankton plants and animals were found in the middle and upper river reaches (123 and 118 taxa, respectively). The more detailed data presented in Tables B-1 and B-2 indicate that about 25 percent more types of planktonic plants were found in the middle reach than upstream but about 20 percent more types of planktonic animals were found in the upstream reach than in the middle one. These differences could be caused by a number of things; however, colder water might limit the variety of planktonic plants that could live in the upstream reach, and a wide variety of fish predators (see below) might reduce the abundance of planktonic animals in the middle reach.

Macrophytes

During the CMCP evaluation, TVA staff also identified the larger plants which routinely live in the water (the aquatic macrophytes). The macrophytes which occurred in the river in the vicinity of each CMCP site were examined during a float survey, and the plants at the specific evaluation sites were carefully documented during a mapping study (Wade and Webb, 1986).

The macrophyte species found at or near the four Duck River CMCP sites are presented in Appendix B, Table B-3, and are summarized in the middle and upper reach columns in Table 11. No comparable sampling has been conducted in the downstream stream reach or in either of the reservoirs. The detailed data show that eight plant species were found in both the middle and upper river reaches, suggesting a fairly uniform aquatic plant community in at least those two parts of the river.

Insects and Other Invertebrates (except Mollusks)

The larger aquatic insects and other types of animals without backbones (invertebrates) which live in the middle reach of the Duck River have been examined several times in recent years by TVA staff and others. Much of this work was done in the early 1980s as part of the CMCP evaluations (primarily Barr et al., 1986); however, other studies were conducted both earlier (TVA, 1975) and later (e.g., Ahlstedt and Saylor, 1992). The bottom-dwelling (benthic) invertebrates present in both Normandy and Tims Ford reservoirs have been sampled several times during the 1990s as part of the TVA Vital Signs Monitoring Program (Dycus, et al., 1999). Unfortunately, neither of these groups of invertebrates have been sampled in the downstream reach of the Duck River included in this assessment. Usually, the animals were preserved in the field and, later, identified using a variety of references. The ease with which these animals could be identified down to the genus or species level depended on the taxonomic group involved, the expertise of the staff making the identifications, and the purpose of the specific project. In virtually all of these groups, there are probably many more species present than have been identified.

The extensive lists of invertebrate species (or higher taxonomic categories) which have been found in at least some of these river and reservoir reaches are presented in Appendix B, Table B-4. All of these records are summarized in two rows of Table 11, in part to help identify some of the differences that are present. The summary numbers for both the insects and the other invertebrates indicate that the most taxa were encountered in the middle reach of the Duck River (142 and 27 taxa, respectively), just over half that many taxa were found in the upstream reach, and very few taxa were found in either of the reservoirs (for example, only three insect taxa and five other invertebrate taxa have been found in Normandy Reservoir). The very few types of insects and other invertebrates encountered in these two reservoirs is typical of tributary reservoirs within the Tennessee Valley (and elsewhere), and probably

indicates the small number of bottom-dwelling species which are able to survive in the slow-moving, relatively cold, at times oxygen-deficient habitats that occur in those reservoirs. The fewer number of taxa present in the upstream reach may be related to effects of the relatively low temperature of the water released from Normandy Dam, perhaps accompanied by some effects from the farms and businesses in the upstream part of the watershed.

Mollusks

Freshwater mollusks are represented in the Duck and Elk River basins by river snails, native mussels, fingernail clams, and the Asiatic clam. These typically large aquatic invertebrates are seldom collected with the dredge or net sampling techniques routinely used to sample insects and other bottom-dwelling invertebrates. During the last 30 years, TVA staff and a few others have conducted several surveys specifically to document the distribution and abundance of the mussels and, occasionally, the aquatic snails which live in the middle and upper reaches of the Duck River. As part of the preparations for this EIS, TVA staff sampled the native mussel species present at two locations in the downstream reach of the river. The results of these studies are summarized in Table 11, and the details are presented in Appendix B, Table B-5.

The numbers of mollusk species presented in Table 11 indicate that the most species (54) were found in the middle reach of the river, approximately half that many were found in both the downstream and upstream reaches, and only one mollusk species was encountered in Normandy Reservoir. Very few mollusks probably occur in the reservoirs for the same reasons few other bottom-dwelling invertebrates are found there; they are not adapted to the slow-moving, relatively cold, sometimes oxygen-deficient habitats that exist in tributary reservoirs. The relatively large number of mussel and snail species found in the middle reach have been known to occur in that part of the Duck River for a long time (e.g., Isom and Yokley, 1968) and represent much of the diversity that was present at least 100 years ago (Ortmann, 1924). The lower numbers of species present in the downstream and upstream river reaches appear to represent reductions from the original diversity probably caused by past pollution events and human disturbances in the watershed (van der Schalie, 1973).

Fish

The fish species which occur in the Duck River have been surveyed more extensively and more often than any other parts of the aquatic communities. The most intensive of these surveys were conducted as part of the CMCP work (summarized in Barr et al, 1986); however, a variety of other surveys or site visits also have contributed many occurrence records (especially Burr et al., 1993; Nieland, 1982; and Scott and Gardner, 1995). During the 1990s, TVA crews also have sampled the fish communities in Normandy and Tims Ford reservoirs as part of the Vital Signs Monitoring Program (Dycus, et al., 1999). All of the fish species encountered during these surveys are listed in Appendix B Table B-6. A summary of this information is included in Table 11.

The numbers of fish species presented in Table 11 indicate more similarity among the river reaches and reservoirs than was apparent for the insects, other invertebrates, or mollusks. The middle reach still yielded the most species (80), but the upstream and downstream reaches were found to have only slightly fewer (72 and 56 species, respectively), and the reservoirs yielded nearly half as many as the middle reach (35 and 36 species). In this case, the raw numbers are somewhat misleading, especially with regard to the reservoirs. The detailed data (presented in Appendix Table B-6) indicate that 25 fish species were found in four or all five of these river or reservoir areas; however, most of the other 77 species occurred only in reaches with more restricted types of habitats. Two families of fishes (the minnows and the darters) were represented by many more species in the river reaches (together between 28 and 42 species) than in the reservoirs (5 or 8 species). Conversely, a few fishes were found only in the reservoirs (e.g., threadfin shad, yellow bass, and yellow perch). In general, the middle reach of the river yielded the most species, with additions or deletions in the other areas depending on the presence or absence of different habitat characteristics (e.g., rainbow trout were found only in the upstream reach, the reach receiving the cold water discharge from Normandy Dam).

River and Reservoir Summary

The total numbers of species (and other taxonomic levels) encountered in these three reaches of the Duck River and Normandy and Tims Ford reservoirs are presented at the bottom of Table 11. These numbers indicate that the middle reach of the river supports the most types of aquatic life (436), followed relatively closely by the upstream reach (323). The numbers of species known from the downstream reach and the two reservoirs are much lower, in part because some major aquatic groups have not been sampled in those areas.

Information presented in the previous paragraphs indicates that, where sufficient sampling has been done, the reservoir habitats support many fewer species than any of the flowing water reaches. Among the three reaches of the Duck River, the upstream reach supports more planktonic animals than the middle reach but fewer species of planktonic plants, insects, other invertebrates, mollusks, and fishes. The most often mentioned possible reason for these differences is the cold water released from Normandy Dam. The downstream reach is represented only by numbers for mollusks and fishes and, in both cases, yielded fewer species than either the middle or upstream reaches. At least with regard to the mollusks, this reach seems not to have completely recovered from the effects of earlier pollution and other human disturbances in the area.

Tributary Habitats

The four action alternatives included in this evaluation could affect several Duck River tributaries if one or more of them were adopted. Poplar and Greenlick creeks occur along the most likely pipeline route from a downstream intake site to the City of Columbia, Fountain Creek and several of its tributaries exist in the watershed which could be impounded to form a Fountain Creek reservoir, and Flat Creek flows along the most likely route of a pipeline between a Tims Ford intake and the closest part of the Duck River (near Shelbyville). Of these streams, Fountain Creek drains the largest watershed (103 square miles), followed by Flat Creek (50 square miles), Greenlick Creek (23.6 square miles), and Poplar Creek is the smallest (6.4 square miles) (TVA, 1970).

Existing and new information about the aquatic life present in these three groups of Duck River tributaries is summarized in Table 12. The detailed information upon which this summary is based is presented in Appendix B, Tables B-7 through B-14. As indicated in Table 12, several taxonomic groups have not been sampled in some of these tributary streams. The information that is available, however, is sufficient to indicate the general quality of these communities and the types of aquatic life that is present.

The numbers of species or other taxonomic levels of the plankton, insects and other invertebrates in the Fountain Creek watershed is derived from sampling conducted by University of Tennessee staff at the Tennessee Route 50A bridge (east of Culleoka) in September 1981 and June 1982 (Etnier, et al., 1983). As indicated in Appendix B Table B-7, the plankton sampling included only the

microscopic plants; the planktonic animals were not sampled. While no similar survey information is available for these parts of the aquatic communities from the downstream or upstream tributaries, incidental observations about the more obvious representatives of these groups was made during rather focused sampling for mollusks and fishes that was conducted by TVA staff in June 1999. For comparative purposes, the numbers of insects and other invertebrates encountered in Fountain Creek (a total of 100 taxa) is comparable to the total for these groups found in the upstream reach of the Duck River (98 taxa, total) but is substantially less than was found in the middle reach of the river (169 taxa).

Table 12. Summary of numbers of aquatic species known from three groups of Duck River tributaries. Supporting data and references are presented in Appendix B.

Plant and Animal Groups	**Greenlick and Poplar Creeks**	**Fountain Creek Watershed**	**Flat Creek Watershed**
Plankton	NS	27+	NS
Plants	NS	NS	NS
Insects	NS	88	NS
Other Invertebrates	NS	12	NS
Mollusks	2	5	8
Fish	25	50	38
Totals	**27+**	**182+**	**46+**

NS - Community not sampled in this reach

Mollusks and fishes in the downstream creeks and Flat Creek were sampled during June 1999 (TVA unpublished data). Mollusk information from the Fountain Creek watershed was collected during the University of Tennessee study (Etnier, et al., 1983) and a TVA survey conducted in 1990 (TVA unpublished data). Most of the mollusks encountered in these creeks were snails; Flat Creek was the only one of these streams found to support as many as four freshwater mussel species. Even though Flat Creek has slightly smaller watershed than Fountain Creek, it was found to support more mollusk species than any of the other tributaries included in this examination.

The fish species occurring in these creeks, like the Duck River, have been the subject of relatively more collection effort and study. In addition to the results of the recent TVA sampling in Poplar, Greenlick, and Flat creeks, several collections have been made in various parts of the Fountain Creek watershed. Perhaps because of the more extensive sampling effort, Fountain Creek yielded the most fish species (50); however, the total for Flat Creek (38) was only slightly lower. Poplar and Greenlick creeks yielded 19 and 16 species, respectively (Appendix B, Table B-14), for a composite total of 25 species.

Tributary Summary

The total numbers of species (and other taxonomic levels) presented at the bottom of Table 12 indicate that the most types of aquatic life were encountered in the Fountain Creek watershed (182+); however, that total included information about several major groups that had not been sampled in the other watersheds. With regard to mollusks and fishes, both of which had been the subject of specific searches in each of these watersheds, the 46 species in these two groups found in the relatively small Flat Creek watershed probably represents the least disturbed of these streams. The 19 fish species found in Poplar Creek, draining a very small watershed, also seems to represent a relatively undisturbed stream. The 55 species of fishes and mollusks found in the Fountain Creek watershed and the 18 species in Greenlick Creek seem lower than expectations would predict. The site sampled on Greenlick Creek, in particular, seemed to have an excessive amount of fine sediment and many species were represented only by single individuals.

4.6 WETLANDS

Wetlands are areas that are wet or covered by shallow water for at least part of the year. Their soil conditions, and the plant and animal life they support, are determined mainly by the presence of water. Most wetlands are dominated by plants that can live in areas that are frequently flooded or have water present for long periods of time. These habitats are generally teeming with life because of the abundant water and nutrient supplies that are available to a wide variety of aquatic and terrestrial plant and animal species. Established wetlands also are important in controlling erosion, preventing flooding and storm damage, improving water quality, and helping to recharge ground water.

Wetlands are protected under both state and federal laws because of the benefits they provide. These "jurisdictional wetlands" (wetlands that meet specific criteria: having wetland plants, wetland soils, and wetland hydrology) are protected under Section 404 of the Clean Water Act. This law is administered by USACE. In addition, Executive Order 11990 (Protection of Wetlands) addresses wetlands located on federal property or affected by federal projects. In Tennessee, activities in wetlands also are regulated by TDEC under the authority of the Tennessee Water Quality Control Act of 1977.

The USFWS has produced a series of National Wetland Inventory (NWI) maps for much of the United States using a habitat-based classification system (Cowardin et al., 1979). This classification system starts out by identifying whether the wetland is basically part of a marsh (palustrine), part of a lake (lacustrine), or part of a stream (riverine). The classification system also identifies more detailed features of the habitat and the vegetation that is present.

Identification of wetlands in the project area was based on the NWI maps and existing color infrared photography of the Fountain Creek watershed. According to the available information, wetlands in the project area fall into three classification types: palustrine forested broad-leaved deciduous wetlands, palustrine scrub-shrub broad-leaved deciduous wetlands, and palustrine emergent, persistent [vegetation] wetlands. The following paragraphs indicate what is known at present about the wetlands that might be affected by each of the action alternatives.

Fountain Creek Reservoir Area

Wetland resources in the possible area of a Fountain Creek reservoir were identified based on an aerial inventory using color infrared photography, in addition to the information on the NWI maps. The results indicate that there are approximately 200 acres of palustrine forested wetlands, and approximately 25 acres of mixed palustrine forested and scrub/shrub wetlands in the project area. These wetland areas typically occur in narrow strips located along Goose Creek, Hurricane Creek, Silver Creek, and Greasy Branch.

Downstream Water Intake Area

The NWI map indicates palustrine forested wetlands associated with Gin Branch, Poplar Creek, and John Branch. There is also an extensive area of forested wetlands associated with the Duck River on the west side of Shelby

Bend and east of Greenfield Island. Several areas of palustrine emergent wetlands occur near the mouth of Poplar Creek. Palustrine scrub-shrub wetlands occur in a small area near the mouth of Poplar Creek and in the north section of Shelby Bend on the Duck River. All together, these areas amount to approximately 90 acres.

Normandy Reservoir Area

The NWI indicates the majority of wetlands are confined to the shallow heads of embayments around the reservoir. Many linear palustrine forested areas occur where tributary streams flow into the reservoir. The NWI indicates two small palustrine emergent wetlands in the Riley Creek embayment, one in the Barton Spring embayment, and another in the upper end of the lake northeast of Bullen Run. Two areas of palustrine scrub-shrub wetlands are located in an embayment just north of the dam. All together, these areas amount to approximately 220 acres.

Tims Ford Pipeline Area

The NWI indicates a number of palustrine forested wetlands in the most likely area where this alternative could be built. These are primarily linear wetlands associated with Flat Creek and its tributaries, and along the Long Creek and Hurricane Creek embayments on Tims Ford Reservoir. Three small palustrine emergent wetlands are indicated in embayments associated with Long Creek and Turkey Creek. Together, these areas amount to approximately 270 acres.

These initial descriptions of possible wetlands associated with the action alternatives were based on NWI map information compiled using high-altitude aerial photography (some of which is more than ten years old), accompanied by more recent data and limited field reconnaissance. While the existing information forms a good starting point, many wetland areas are small and/or hard to identify from high-altitude photographs. In addition, wetlands can change into other types of habitats over time, especially when landowners want to use the land for other purposes.

4.7 FLOODPLAINS/FLOOD CONTROL

Information exists about Duck River floods in the Columbia area from as early as 1814, but the first flood for which any elevation data are available occurred in 1874. The largest known flood in Columbia occurred in February 1948

when the Duck River exceeded bank-full stage by almost 20 feet. Other information about the flood history of the area is available in records maintained by the U.S. Geological Survey and TVA.

The Federal Emergency Management Agency coordinates the identification of floodplains and the preparation of Floodplain Maps in cooperation with local governments all across the country. Communities and other local agencies use the Floodplain Maps to establish the limits of floodplain areas in the community and to adopt specific floodplain regulations as the basis for their zoning or other flood protection planning measures.

Within this general project area, Maury, Marshall, and Moore counties, and Columbia and Shelbyville participate in the National Flood Insurance Program (NFIP) and have adopted the 100-year flood as the basis for their local floodplain regulations. Bedford and Coffee counties do not participate in the NFIP; however, some floodplain areas have been identified in parts of these counties.

With regard to the streams in this study area, floodplains have been identified and Floodplain Maps have been prepared for all of the included reach of the Duck River and for numerous other streams. This information has been made available to the counties and cities, and is being used in their floodplain management programs. The following paragraphs describe floodplain-related features specific to each of the action alternatives.

Fountain Creek Reservoir Area

The area most likely to be affected by the construction of this reservoir would be Fountain Creek between Creek Miles 0.2 and 14, Silver Creek between Creek Miles 0.0 and 5.0, Globe Creek between Creek Miles 0.0 and 2.5, and other minor tributaries in that part of the Fountain Creek watershed. The 100-year floodplain for Fountain Creek varies from elevation 604.1 feet mean-sea-level (msl) at the mouth (Creek Mile 0.0) to elevation 662.9 feet msl at Creek Mile 13.87. The 500-year (or "critical action" floodplain) on Fountain Creek varies from elevation 608.7 feet msl at the mouth to elevation 664.2 feet msl at Creek Mile 13.87.

With regard to the Fountain Creek tributaries, the 100-year floodplain on Silver Creek varies from elevation 604.1 feet msl at its mouth to elevation 660.6 feet msl at Silver Creek Mile 4.67. The 500-year floodplain on Silver Creek varies

from elevation 608.7 feet msl to elevation 661.1 feet msl at Creek Mile 4.67. The Globe Creek 100-year floodplain varies from elevation 648.9 feet msl at the mouth to elevation 657.1 feet msl at Creek Mile 2.24. The Globe Creek 500-year floodplain varies from 652.4 feet msl at the mouth to elevation 658.6 feet msl at mile 2.24. There is no flood information available for the other tributaries; however, the published Floodplain Maps for this area show the approximate 100-year floodplains for several streams.

Downstream Water Intake Area

Construction of a water intake downstream from the mouth of Catheys Creek and an associated pipeline would occur more or less along the Duck River from River Mile 104.4 to about River Mile 125 or 130. The approximate 100-year floodplain at Duck River Mile 104.4 is the land below elevation 538 feet msl and the approximate 500-year floodplain is the area below elevation 544 feet msl. The pipeline route would cross several streams, and the 100-year floodplains of these streams could be impacted by this construction. There is no flood information available for these tributary streams; however, the published Floodplain Maps for this area show the approximate 100-year floodplains for several of them. Detailed flood information is available for Greenlick Creek and Little Bigby Creek.

Normandy Reservoir Area

Under this alternative, the height of the existing Normandy Dam at Duck River Mile 248.6 would be raised to increase the volume of water that could be stored behind the dam. The 100- and 500-year floodplains on Normandy Reservoir are the areas below elevation 880.0 feet msl. The approximate floodplain area is shown on the published Coffee County, Tennessee, and Bedford County, Tennessee Floodplain Maps.

Tims Ford Pipeline Area

The area most likely to be affected by construction of an intake on Tims Ford Reservoir and an associated pipeline would extend from Tims Ford Reservoir to Shelbyville, Tennessee. The 100-year floodplain for Tims Ford Reservoir is the land below elevation 894.2 feet msl and the 500-year floodplain on the reservoir is the area below elevation 894.7 feet msl. The pipeline route would cross several small streams in the Flat Creek watershed and the 100-year floodplains of these streams could be impacted by this construction. No flood information is available for these streams; however, the published Floodplain Maps for this area show the approximate 100-year floodplains for some of them.

4.8 TERRESTRIAL LIFE

As indicated in Section 4.2, this project area occurs in the Central Basin Section of the Interior Low Plateau Province and adjacent parts of the Western and Eastern Highland Rim as described by Fenneman (1938). The Central Basin consists of areas with fertile soils, especially near the main rivers and less fertile areas with thin, rocky soils. Near its boundary with the Central Basin, the Highland Rim consists of rolling hills and incised valleys.

The terrestrial plant and animal communities that occur in this area all exist within the Western Mesophytic Forest Region (Braun, 1950). This forest region roughly coincides with the Interior Low Plateau but, in Tennessee, extends westward to the loess bluffs adjacent to the Mississippi River. This is a transitional region between the Mixed Mesophytic Region to the east, where numerous tree species share the canopy in mature forests, and the Oak-Hickory and Southeastern Evergreen Forest Regions to the west, both of which include few canopy tree species in mature forests. Forests of the Western Mesophytic Region have several dominant tree species in the canopy and a relatively large number of oak and hickory species. Many of the trees that help characterize the Mixed Mesophytic Region (such as yellow buckeye, basswood, hemlock, and white pine) are uncommon or absent in Western Mesophytic Region forests.

Many distinct terrestrial communities occurred in this area before European settlement of the region. During the past 200 years, human activities have greatly altered the previous vegetation and have produced a complex mixture of vegetation types. The most significant change from pre-settlement conditions has been the decrease in forest cover and the increase in pastures and croplands. Even in pre-settlement times, however, open areas existed in the form of limestone glades, barrens, and other areas kept open by fires, either started by lightning or set by Native Americans.

The terrestrial communities in this project area can be broadly categorized as bottomland hardwoods, mixed hardwoods, cedar-hardwoods, cedar forests, agricultural lands, brushy thickets (including fencerows), limestone glades, and barrens. In addition, communities associated with seepage areas, bluffs and cliffs, and caves are extremely uncommon but quite important to the regional biodiversity. These categories, although somewhat artificial and intergrading, cover the range of terrestrial communities which occur in the area. These

communities, arranged from wettest to driest, are described in the following paragraphs. The types of terrestrial communities that could be affected by each of the action alternatives are indicated in paragraphs near the end of this section.

Bottomland hardwood communities occur along the Duck River and its major tributaries. Such forests typically have various mixtures of box elder, red maple, sweet gum, river birch, sycamore, willow oak, water oak, and river cane. Depending on the extent and nature of the flooding, the herb and shrub layer may be extremely sparse or well-developed. Areas with a well developed herb/shrub layer may contain such species as chickweed, corn salad, bedstraw, field garlic, buttercups, violets, trillium, hen-bit, and coral-berry.

Bottomland hardwoods provide breeding sites and travel corridors for migrating neotropical birds, along with providing roosting and foraging habitat for a variety of semi-aquatic animals. Species of wildlife commonly found in these areas include belted kingfisher, blue-gray gnatcatcher, muskrat, beaver, mink, gray squirrel, white-tailed deer, and a variety of reptiles. Woodland depressions in bottomland hardwoods that are periodically inundated during winter months provide important breeding sites for numerous species of woodland salamanders including spotted and marbled salamanders. These woodland depressions are rare in middle Tennessee.

Seepage areas typically occupy less than one acre and normally occur on level or gently sloping sites. They may or may not be forested. These communities are vulnerable to habitat disturbances and changes in the hydrological regime. Seepages are often used extensively by large numbers of amphibians such as dusky and long-tailed salamanders.

Mixed hardwood stands are found most commonly on lower and mid-slope terrain and on sites where deeper soils have accumulated. Typical tree species in these stands include white oak, northern red oak, shumard oak, chinquapin oak, post oak, sugar maple, mockernut hickory, pignut hickory, shagbark hickory, black cherry, persimmon, hop-hornbean, and slippery elm. Shrub species characteristic of these areas include fragrant sumac, Carolina buckthorn, coral-berry, and leafy hypericum.

Mixed hardwood forests provide habitat for a variety of wildlife. Species such as white-tailed deer, gray squirrel, southern flying squirrel, and wild turkey are

typical of these areas. Many species of neotropical birds also nest and migrate in mixed hardwood forests.

Bluff or cliff areas occur along various parts of the Duck River in this project area. These habitats are typically very steep and may be partially or completely forested. Depending on where they occur, these habitats can vary from moist, dripping cliff faces to extremely dry bluff tops.

Bluffs can provide nesting and roosting habitat for black and turkey vultures and a variety of bat species. Crevices in bluff faces provide habitat for a variety of salamanders such as long-tailed, green, and slimy salamanders.

Agricultural lands include hayfields, pasture lands, and tracts in row crops such as cotton, soybeans, and corn. These lands typically have the featured agricultural crop and additional native or exotic weed species. Depending upon characteristics of the individual tract, these weeds may include sericea lespedeza, broom-sage, Japanese honeysuckle, buttercups, chickweed, smartweeds, numerous grasses, and dandelion.

Although heavily modified by man, agricultural lands provide habitat for many species of wildlife. Common species include eastern meadowlark, northern mockingbird, song sparrow, eastern cottontail rabbit, least shrew, and hispid cotton rat.

Brushy thicket communities are found in areas that have been severely disturbed and are revegetating. Disturbance in these areas is usually five to 20 years old, and woody plants are dominant in dense thickets of shrubs and tree saplings. Common species usually found in these areas include eastern red cedar, winged elm, persimmon, Carolina buckthorn, redbud, hackberry, osage-orange, sugar maple, Japanese honeysuckle, coral-berry, and sericea lespedeza. Because of the similarity of species which occur in these areas, fencerows are included in this cover type.

Common wildlife found in thickets include a variety of birds such as field sparrows, indigo bunting, eastern meadowlark, and prairie warbler. Common mammals include white-footed mice, skunk, opossum, woodchuck, least shrew, and hispid cotton rat. A variety of amphibians and reptiles including upland chorus frogs, American toad, and fence lizard can be found in these habitats.

Barrens are dynamic communities typically maintained by disturbance, such as fire. These areas are sparsely forested with oaks and have abundant grasses and herbs as a ground cover. Barrens communities usually occur on relatively level ground on the Highland Rim and have restricted water flow under the soil surface. On the eastern Highland Rim in Tennessee, the habitat types historically associated with barrens are oak woodland, oak savanna, shrub-grassland, and prairie-like openings.

Animals that favor early successional habitats, such as prairie warbler and indigo buntings, are often found in barrens habitats. Amphibians, such as upland chorus frogs, northern cricket frogs and American toads, often breed in temporary pools that form in these areas during frequent spring rains.

Cedar-hardwood forests have essentially the same tree and shrub species as the mixed hardwood forests of the region. They differ, however, in that eastern red cedar makes up one-third or more of the stand canopy. In addition, cedar-hardwood forests tend to have less white oak, scarlet oak, and black cherry, and more chinquapin oak, post oak, hop-hornbean, leafy hypericum, and fragrant sumac compared to the mixed hardwood forests. Cedar-hardwood is probably the most abundant forest type in the Central Basin portion of the project area.

Cedar forests occur on various sites in the area. Although any plant species encountered in cedar-hardwood forests could be found in small numbers in cedar forests, these stands are dominated by eastern red cedar. Cedar forests typically occur in areas where conditions are extremely favorable for their establishment and growth. Where dense stands are at least 40 years old, there is sparse undergrowth on the forest floor, partly due to dry conditions usually associated with such habitats and partly because of the dense shade created by a closed cedar canopy.

Dense stands of cedars are often used as nesting and roosting sites for birds such as common grackle. Cedar forests are used extensively as cover by white-tailed deer and eastern cottontail rabbit.

Cedar glade communities are open, rocky, treeless areas that are typically surrounded by eastern red cedar trees. Glades occur where particular types of limestone bedrock are covered with such shallow soil that trees cannot become established. Cedar glades are found only in limited areas of a few southeastern

states. In addition to the rarity of this habitat type, many of the plant species found within these glades have extremely limited ranges. Glades in the project area are important from a state and regional perspective. Large, undisturbed glades or those having rare species warrant special protection.

Wildlife commonly found in cedar glades include those species commonly found in early successional habitats such as yellow breasted chat, prairie warbler, indigo bunting, eastern cottontail rabbit, and fence lizards.

Caves are unique terrestrial habitats. Caves are very fragile ecosystems that often provide habitat for a variety of animal species. Wildlife commonly found in caves include a variety of bats, small mammals, and amphibians. Several caves are known from this general project area; however, few caves in the vicinity have been surveyed to determine which animals are present.

Fountain Creek Reservoir Area

As indicated in Section 4.9, much of the area that would be affected by construction of this reservoir is presently maintained as agricultural fields and pastures. Natural communities remaining on parts of this land include bottomland hardwoods, seepage areas, bluff or cliff areas, and cedar glades. Most of the bottomland hardwoods and seepage areas occur along Fountain and Silver creeks. Bluff and cliff habitats are not present in the Fountain Creek watershed but do occur along the Duck River downstream from the mouth of Fountain Creek and may exist along the pipeline corridor route. Cedar glades occur along the northwestern edge of the area that could be affected by this alternative.

Although much of Fountain Creek flows through agricultural lands, several well established forested riparian zones exist within the watershed. These areas are used as travel corridors and nesting sites for neotropical birds, bats, and a variety of other wildlife species.

Downstream Water Intake Area

Construction of a new water intake on the Duck River in the vicinity of Kettle Mills and an associated pipeline to connect to the water distribution system probably would affect existing road rights-of-way for most of its length. Much of this area, especially along the highways, is now managed as agricultural land. Native communities in this area include bottomland hardwoods, seepage areas, and bluff or cliff areas.

Bottomland hardwood communities occur along the part of the Duck River that could be affected by this alternative. Specific seepage areas have not been identified within this area but, if they are present, would most likely be found along the Duck River and its tributaries. Bluff or cliff habitats have not been encountered in this area; if these habitats are present, they would be found along the Duck River. Wildlife in this area consists of species that are locally and regionally abundant.

Normandy Reservoir Area

Lands immediately adjacent to Normandy Reservoir vary from forested slopes to open agricultural fields and residential developments. Forests adjacent to Normandy Reservoir are predominately upland hardwoods, cedar-hardwoods, pure stands of eastern red cedar, and bottomland hardwoods. Uncommon natural communities that may be associated with this alternative include bottomland hardwood forests, seepage areas, bluffs and cliffs, and barrens.

Bottomland hardwood communities and seepage areas are not presently known within the area likely to be affected by this alternative. If such habitats are present they would most likely be found along the Duck River below Normandy Dam, along the Normandy Reservoir shoreline, or along the tributaries flowing into Normandy Reservoir. No bluff, cliff areas, or barrens communities are presently known to occur within the footprint of this alternative and no likely locations for such communities have been identified (Call, 1998). Several caves are known to occur in the vicinity of Normandy Reservoir.

Tims Ford Pipeline Area

Forest lands around this reservoir include upland hardwoods, cedar-hardwoods, and bottomland hardwoods. The remaining forest lands are dominated by pure stands of eastern red cedar. Bottomland hardwoods and wetlands are both extremely rare on Tims Ford Reservoir. Bottomland hardwoods are dominated by box elder, sycamore, river birch, and hop-hornbeam. Upland hardwoods are dominated by oaks (white, black, scarlet, and chestnut), blackgum, sourwood, and hickory. Beech, sugar maple, basswood, and yellow poplar are common on more moist sites. Large mature deciduous forest are rare on Tims Ford and occur primarily in areas that were too steep to easily log or develop.

Most wildlife habitat associated with this alternative consists of agricultural fields and upland hardwood forests. Uncommon terrestrial communities

include bottomland forests, seepage areas, bluffs and cliffs, cedar glades, and barrens. Bottomland hardwood communities are uncommon and exist mostly along the Elk River downstream from Tims Ford Dam. One bottomland hardwood forest exists just upstream of Tims Ford Reservoir along the Elk River. This bottomland hardwood forest has been identified as a significant breeding site for woodland salamanders.

Rocky seepage areas are known to occur at several locations in the area likely to be affected by this alternative. These seepages, which occur in mid-age and mature woodlands, vary in slope, and continuously discharge water from fractured rock formations. The outcrops usually include both limestone and shale layers. A variety of mosses, liverworts, herbaceous plants, and woody plants occur at these sites. A variety of woodland salamanders also occur in these areas.

Bluff or cliff areas are known from along the shoreline of Tims Ford Reservoir, as well as along the Elk River where it enters the reservoir. These areas are often used as day roosts by bald eagles during winter months and are extensively used by a variety of small mammals and amphibians. No barrens communities are presently known to occur within the footprint of this alternative; however, barrens do occur on the Arnold Engineering Development Center, approximately four miles northeast from the possible intake locations (Call, 1998).

4.9 ENDANGERED AND THREATENED SPECIES

As discussed in Sections 4.5 and 4.8, the descriptions of aquatic and terrestrial life indicate that a wide diversity of plant and animal species occur in this part of Tennessee. Some of the species known from this region are protected under federal and state endangered species laws. In fact, available information suggests that 115 species now protected under federal and/or Tennessee endangered species laws have been reported from the five counties which could be affected by one or more of the action alternatives (Maury, Marshall, Bedford, Coffee, and Moore counties). The names and county occurrence information for all of these species are presented in Appendix C. Table 13 presents a brief summary of this information focused on their federal or state protection status.

Table 13. Summary of the numbers of federal and Tennessee endangered, threatened, and other categories of protected species known from the five counties included in this evaluation. Some of these species are protected at both the state and federal level and are counted in both summaries.

Categories	Animals	Plants	Totals
Federal Status			
Endangered	15	3	18
Threatened	1	1	2
Identified Candidates	1	0	1
Federal Totals	17	4	21
Tennessee Status			
Endangered	16	22	38
Threatened	8	26	34
Other Status	23	20	43
Tennessee Totals	47	68	115

The tables included in Appendix C also indicate the one or two types of habitats in which each protected species is typically found. This information, summarized in Table 14, indicates that most of the protected species occur only in a few of the habitats that exist in this project area. Of the identified habitats, wet meadows and creeksides contain the most protected species (26, all plants; 23 percent of the overall total), followed by rivers, where 20 species (17 percent of the total, all but one animals) are found. If similar habitats are grouped together, rivers and creeks support 35 species (30 percent of the protected species, all but one animals), followed closely by the 31 species which occur in wet meadows, creeksides, and seepage areas (27 percent of the total, all plants). Bottomland and mixed forests account for 18 percent of the total (half animals, half plants), cedar glades 11 percent (all plants), disturbed areas (agricultural areas, old fields, thickets, and barrens) eight percent (mostly plants), and bluffs and cliffs four percent (again mostly plants). Only one percent of the protected species occur on reservoirs (the bald eagle) and no protected species are reported as routinely occurring in cedar forests.

Table 14. Summary of the numbers of protected species known from the major habitat types present in the five counties included in this evaluation.

Habitat Associations	Animals	Plants	Totals
Aquatic			
Creeks	15		15
Rivers	19	1	20
Reservoirs	1		1
Underground Streams	1		1
Terrestrial			
Wet Meadows, Creeksides		26	26
Seepage Areas		5	5
Bottomland Forests	6	5	11
Mixed Hardwoods	3	7	10
Bluffs and Cliffs	1	4	5
Agricultural Areas	2	1	3
Old Fields, Thickets, Fencerows		1	1
Barrens		5	5
Cedar Forests			
Cedar Glades		13	13

Federal Protected Species

The information presented in Table 13 indicates that 21 species known from this 5-county area are protected under the federal Endangered Species Act. Some of these species, however, no longer occur in these counties and some of them occur only in parts of the counties that would not be affected by any of the action alternatives. Because of their federal protection status, these 21 species are individually identified in Table 15 and their potential to occur in the project area is described in the following paragraphs.

Plants

Chaffseed (*Schwalbea americana*) was listed as a federal endangered species in 1992 (USFWS, 1992). Primarily a coastal plain species, chaffseed was last observed in Tennessee in 1879. Although this species still survives in the coastal plains of New Jersey, North and South Carolina, Georgia, and Florida (USFWS, 1994), it is highly unlikely chaffseed persists within the project area.

Table 15. Federal endangered, threatened, and formal candidate species known from the five county area which could be affected by one or more of the action alternatives.

Common Name	Scientific Name	Federal Status	Likely in Project Area?
Plants			
chaffseed	*Schwalbea americana*	E	No
Eggert's sunflower	*Helianthus eggertii*	T	No
leafy prairie-clover	*Dalea foliosa*	E	Yes
yellow-eyed grass	*Xyris tennesseensis*	E	No
Mollusks			
birdwing pearlymussel	*Lemiox rimosus*	E	Yes
cracking pearlymussel	*Hemistena lata*	E	No
Cumberland combshell	*Epioblasma brevidens*	E	Yes
Cumberland monkeyface	*Quadrula intermedia*	E	Yes
Cumberland pigtoe	*Pleurobema giberum*	E	No
orange-footed pearlymussel	*Plethobasus cooperianus*	E	No
oyster mussel	*Epioblasma capsaeformis*	E	Yes
pale lilliput pearlymussel	*Toxolasma cylindrellus*	E	Yes
shiny pigtoe	*Fusconaia cor*	E	No
slabside pearlymussel	*Lexingtonia dolabelloides*	C	Yes
tan riffleshell	*Epioblasma walkeri*	E	Yes
tuberculed-blossom pearlymussel	*Epioblasma t. torulosa*	E	No
turgid-blossom pearlymussel	*Epioblasma turgidula*	E	No
yellow-blossom pearlymussel	*Epioblasma f. florentina*	E	No
Birds	*Haliaeetus leucocephalus*		
bald eagle		T	Yes
Mammals			
gray bat	*Myotis grisescens*	E	Yes
Indiana bat	*Myotis sodalis*	E	Yes

Eggert's sunflower (*Helianthus eggertii*) was listed as a federal threatened species in 1997 (USFWS, 1997b). This species is associated with dry, upland, acidic pH, barren habitats in the Highland Rim Province. It is known from twelve counties in Tennessee, four counties in Kentucky, and one county in Alabama (USFWS, 1996 and unpublished information). One of the Tennessee populations occurs in Maury County, approximately 12 miles southwest of Columbia. This sunflower was not found during extensive surveys of the Columbia Project lands and is not known to occur in the Central Basin Physiographic Province. The limestone barrens in the Central Basin produce a habitat with a basic pH, substantially different from the acid barrens on the Highland Rim where Eggert's sunflower sometimes occurs (USFWS, 1998a).

The **leafy prairie-clover** (*Dalea foliosa*), a member of the bean family that stands 12 to 24 inches in height, has bluish-purple flowers and blooms in July and August (USFWS, 1996). Leafy prairie-clover was listed as a federal endangered species in 1991 (USFWS, 1991b). This species occurs in seven middle Tennessee counties, two counties in north Alabama, and a single county in Illinois (USFWS, 1996). Four populations have been found on the Columbia Project lands, two of which are among the healthiest and largest known. The larger of these populations was discovered after the recovery plan was approved. The leafy prairie-clover is found along intermittent streams bordering limestone glades rather than on the bare rock of the glades themselves.

Yellow-eyed grass (*Xyris tennesseensis*), listed as a federal endangered species in 1991 (USFWS, 1991a), is a perennial typically found on seepage-slopes, springy meadows, or the banks of small, gravelly streams (USFWS, 1994b). This species is known from twelve locations within the Highland Rim physiographic province in Tennessee. The single record from the counties involved in this project occurs approximately eight miles from Normandy Reservoir, outside of the area which could be affected by any of the alternatives.

Mollusks

Seven of the 14 freshwater mussel species included in Table 14 have been found in the upper Duck River watershed within the last 25 years. Each of those species is described in one or more of the following paragraphs. The other seven mussel species fall into three groups. Three of these species (tuberculed-blossom, turgid-blossom, and yellow-blossom) have not been encountered in any part of their former habitats in the last thirty years and are presumed to be extinct (Williams, et al., 1993). Three others (cracking, orange-footed, and shiny pigtoe) survive in the lower Elk River and in other river reaches; however, none of them are known to persist in the parts of the Duck or Elk river watersheds which could be affected by one or more of the action alternatives. The remaining species (Cumberland pigtoe) is generally assumed to be restricted to the Collins River and, possibly, other nearby streams in the Cumberland River basin; however, an individual identified as this species was found in 1993 in the upper Elk River basin (Parmalee and Bogan, 1998).

The **birdwing pearlymussel** (*Lemiox rimosus* = *Conradilla caelata*), listed as a federal endangered species in 1976 (USFWS, 1976), is the most abundant of the endangered mussel species known from the Duck River. During detailed surveys conducted in both 1979 and 1988 (Ahlstedt, 1986; Jenkinson, 1988), the birdwing was found from Duck River Mile 147 upstream to River Mile 179 and was the fourth (in 1979) or sixth (in 1988) most abundant mussel species encountered in the quantitative samples that were taken (Jenkinson, 1988). More recent sampling indicates this species continues to occur throughout this river reach (Aquatic Resources Center, 1995b) and continues to be one of the more abundant species (Aquatic Resources Center, 1997). This species has not been found in the Duck River downstream from River Mile 147 or in any Duck River tributary. Outside of the Duck River basin, native populations of the birdwing pearlymussel occur (but are extremely rare) in a short reach of the Elk River and in longer reaches of the Powell and Clinch Rivers (Ahlstedt, 1984a).

In 1982, TVA staff transplanted members of this species from the Duck River to sites on the Buffalo, Nolichucky, and North Fork Holston Rivers, and to a site on the upper Duck River near Shelbyville (Jenkinson, 1983). Results of monitoring studies indicate that numbers at all four transplant sites have declined to very low levels; however, the recovery of a few young individuals suggests the introduced birdwings have successfully reproduced in both the North Fork Holston and Nolichucky Rivers (Aquatic Resources Center, 1994a; 1996a).

The **Cumberland combshell** (*Epioblasma brevidens*) was added to the federal endangered species list in 1997 (USFWS, 1997a). This species survives in the Clinch, Powell, and Duck Rivers in the Tennessee River basin and in Buck Creek and the Big South Fork in the Cumberland River basin. A few, old specimens of the Cumberland combshell also may persist in the main Cumberland River downstream from Cordell Hull Dam (USFWS, 1997a). This species was rare but routinely found in the middle reach of the Duck River through the mid-1970s (Ahlstedt, 1981); however, only two live animals have been encountered in this river in recent years (Ahlstedt, 1986; Jenkinson, 1988; Aquatic Resources Center, 1994b; 1996b; 1997; USFWS, 1998b).

The **Cumberland monkeyface** pearlymussel (*Quadrula intermedia*) was placed on the federal endangered species list in 1976 (USFWS, 1976). During various surveys and field activities in the Duck River starting in 1979, no more than 15

live individuals of this species (out of several thousand live mussels) have been found at sites between River Mile 162 and River Mile 179 (Ahlstedt, 1986; Jenkinson, 1988; Aquatic Resources Center, 1994b; 1996b; 1997). In addition to the Duck River, the species survives in very low numbers in a 40-mile reach of the Elk River and in a 30-mile reach of the Powell River (Ahlstedt, 1984b; Ahlstedt, 1986; TVA, unpublished data). This species typically occurs in medium and larger rivers; no individuals have been found in any Duck or Elk River tributaries.

The **oyster mussel** (*Epioblasma capsaeformis*), added to the federal endangered species list in 1997 (USFWS, 1997a), was found in the middle reach of the Duck River during the 1970s (Ahlstedt, 1981). For several years in the 1980s only a few specimens of the oyster mussel were collected in this area (USFWS, 1997a), but, more recently, Aquatic Resources Center staff have encountered this species routinely not far downstream from Lillard Mill Dam (Aquatic Resources Center, 1994b; 1996b; 1997; USFWS, 1998b). Outside of the Duck River watershed, the oyster mussel survives in the Clinch, Powell, and, possibly, Nolichucky River systems in the Tennessee River basin, and in Buck Creek and the Big South Fork in the Cumberland River basin (USFWS, 1997a).

The **pale lilliput pearlymussel** (*Toxolasma cylindrellus*) is known to occur in Rock Creek (a Duck River tributary); however, it has not been found anywhere in the main Duck River or in any other part of this project area within the last 25 years (Parmalee and Bogan, 1998). Outside of Big Rock Creek, the pale lilliput is only known from the Paint Rock River in north Alabama (Ahlstedt, 1984c). It was listed as a federal endangered species in 1976 (USFWS, 1976).

The **slabside pearlymussel** (*Lexingtonia dolabelloides*) is not presently protected under federal or Tennessee endangered species laws; however, it is an identified federal candidate for potential listing (USFWS, 1999). This species occurs in the middle and lower sections of the Duck River included in this evaluation and in the Elk River some distance downstream from Tims Ford Dam (Ahlstedt, 1986). The slabside pearlymussel has not been encountered in any Duck River tributaries in recent years (TVA unpublished data). Outside of the Duck and Elk River systems, the slabside pearlymussel still occurs in parts of the Clinch, Powell, Holston, Hiwassee, and Paint Rock rivers (Parmalee and Bogan, 1998).

The **tan riffleshell** (*Epioblasma walkeri*) was added to the federal endangered species list in 1977 (USFWS, 1977b) and, for several years, was thought to survive only in the Middle Fork Holston River (Neves, 1984). Now, the species is also known to be present in a short reach of the upper Clinch River (USFWS, unpublished data), in the Hiwassee River just downstream from Apalachia Dam (Parmalee and Hughes, 1994), and, may be present in part of the Big South Fork of the Cumberland River (S. A. Ahlstedt, personal communication). In 1988, TVA staff found a young, fresh-dead tan riffleshell in the Duck River at River Mile 151 (Jenkinson, 1988). No other members of this species have been found in more recent sampling on the Duck River (Aquatic Resources Center, 1994b; 1995b; 1997). This species apparently survives in the Duck, Clinch, Hiwassee, Big South Fork, and Middle Fork Holston Rivers but at extremely low numbers in each stream.

Bird

The **bald eagle** (*Haliaeetus leucocephalus*), presently listed as a federal threatened species, is known to occur in this area, at least on an occasional basis. Southern populations of bald eagles were listed as a federal endangered species in 1967 (USFWS, 1989) and, recently, have been proposed for de-listing (USFWS, 1999). Bald eagles typically nest along rivers or reservoirs. Both Tims Ford and Normandy Reservoirs are suitable nesting and foraging areas for bald eagles. Migrating bald eagles are regularly observed on both reservoirs during winter months, and a pair of bald eagles attempted to nest near Normandy Reservoir.

Mammals

The **gray bat** (*Myotis grisescens*), listed as a federal endangered species in 1976, is a colonial bat that roosts in caves year-round (Brady et al., 1982). Gray bats typically roost in caves along rivers and reservoirs within a range primarily restricted to the karst regions of the southeastern United States. Gray bats have been reported to roost in a cave on the Columbia Project lands as they migrate through the area in spring and autumn. Large ceiling stains found in several rooms within this cave suggest that large numbers of bats could be involved. Gray bats probably also use other caves along the Duck River as temporary roosting areas. Gray bats breed during the fall migration, making transition caves (such as those along the Duck River) important to the survival of the species. They also probably feed over the Duck River and its tributaries when they are in the area.

The **Indiana bat** (*Myotis sodalis*) also is likely to occur in this area. This bat was listed as a federal endangered species in 1967 (USFWS, 1967). These colonial bats hibernate in caves during winter months, and form small maternity colonies in hollow trees and beneath exfoliating bark during the summer (USFWS, 1983). Indiana bats are known only from the eastern half of the United States and, apparently, are more abundant in Indiana and Missouri than in Tennessee and Alabama. Recent discussions with Indiana Bat Recovery Team members indicate that population levels of Indiana bats are decreasing throughout their range. Indiana bats have been reported from a cave in Maury County approximately nine miles from part of the Columbia Project lands. Although no Indiana bats were encountered during recent cave surveys on the Columbia Project lands, members of this species may forage and roost in forested areas in this part of Maury County during summer months.

4. 10 LAND USE/PRIME FARMLAND/COMMUNITY NOISE

Land Use

As indicated in Section 1.6, this project area includes various parts of the upper Duck River watershed. Most of this watershed area presently is being used as forest land and agricultural land. The larger cities within the area are Columbia, in Maury County; Shelbyville, in Bedford County; and Tullahoma, in Coffee County. Several of the alternatives would affect land in the Columbia area, and the possible construction of a reservoir in the Fountain Creek watershed would affect the largest amount of land.

Information available from the Environmental Protection Agency's BASINS watershed database (USEPA, 1998) helps characterize how the land in this watershed is presently being used. As indicated in Table 16, 48.1 percent of the upper Duck River watershed is covered by various types of forests (also see Section 4.8), 45.1 percent of the land is used for agriculture, and 2.9 percent of the land is in residential use. All other uses of the land in the upper Duck River watershed affect only 3.9 percent of the area. The 1992 Census of Agriculture data for Maury County indicated that 245,681 acres of land was occupied by farms. This is 62.5 percent of the total area in the county. Similar figures compiled in 1982 indicated that 281,802 acres were in farmland, suggesting a 9.2 percent decrease in farm acreage within Maury County during that 10-year period.

When just the land in the Fountain Creek watershed is considered, forests occupy 39.8 percent of the land, agricultural use occurs on 51.6 percent, and 4.2 percent is in residential use (Table 16). Other uses of the land in the Fountain Creek watershed affect only 4.4 percent of the area.

Table 16. Land use in the Upper Duck River watershed, and in the Fountain Creek watershed.

Land Use *	Upper Duck River Watershed *		Fountain Creek Watershed **	
	Acres	Percent	Acres	Percent
Agriculture Use	2,251,774	45.1	33,913	51.6
Forestland	2,401,725	48.1	26,163	39.8
Residential	145,710	2.9	2,776	4.2
Transitional Areas/Shrub & Brush	83,085	1.7	1,330	2.0
Industrial/Commercial/ Other Built-Up Areas	42,666	0.9	946	1.4
Wetlands	20,709	0.4	459	0.7
Water Bodies/Streams	37,177	0.7	186	0.3
Strip Mines/Disturbed Areas	7,236	0.1	12	0.1
Total Area	4,990,080	100.0	65,785	100.0

* - Environmental Protection Agency, "Upper Duck, BASINS Core Data", 1998 (http://www.epa.gov/OST/BASINS/HUCS/06040002/)
** - TVA unpublished data

Prime Farmland

Prime farmland soils, as defined by the U.S. Department of Agriculture, have properties needed for the economic production of sustained high crop yields. These soils have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. Soils identified as prime farmland soils may presently be in use as cropland, pasture land, range land, forest land, or other uses, but cannot be in use as urban or built-up land. Of the total 392,960 acres of land in Maury County, approximately 112,000 acres (28 percent) is considered prime farmland soils.

The conversion of farmland and prime farmland soils to industrial and other nonagricultural uses essentially precludes producing crops on the land for the

foreseeable future. The 1981 Federal Farmland Protection Policy Act recognized the serious impacts of prime farmland loss on food and fiber production and established requirements for evaluating land prior to permanent conversion from farmland as a result of a federal action. The Act requires that a Farmland Conversion Impact Rating form be completed by federal agencies with assistance from the U.S. Department of Agriculture's Natural Resource Conservation Service. The evaluation rating is based on soil characteristics and site assessment criteria. Land with a rating of at least 160 (out of a possible score of 260) must be given consideration for protection. The Act only suggests that the land be protected and that other sites be considered; there is no legal requirement to do so.

Community Noise

As indicated above, most of the land in the upper Duck River watershed outside of the larger cities is predominantly light to moderate density rural residential and appears to be a broad mixture of old to new and low- to high-cost homes. Landowners primarily use their land for domestic, agricultural, and recreational purposes. These uses would include noise sources such as vehicles, lawn mowing equipment, agricultural equipment, chain saws, dogs, and recreational activities. Some parts of this area border major highways, such as Interstate 65, State Route 50, and State Route 41A. Vehicles are the dominant noise sources in these areas.

A few noteworthy departures from this typical pattern exist in the area. These departures represent the types of local variations that can occur in a rural, unzoned environment and can affect community noise impacts. Active quarrying of limestone is occurring in at least two areas: just north of Iron Bridge Road, across from the former Columbia dam site, and just off of Blue Springs Road near State Route 50. Typical quarrying and industrial noise is coming from both of these sites, along with vehicle noise produced by the heavy trucks which travel the adjacent roads to access these facilities.

A different type of departure from the typical noise pattern has occurred due to the completion of Tom Hitch Parkway between State Routes 412 (on the north) and 50 (on the south). Frontage land along this parkway is being developed for commercial uses, resulting in increased construction noise. As the area continues to develop, operational noises will increase from the new commercial and industrial facilities and vehicle noise will increase as the traffic count grows.

Fountain Creek Reservoir Area

Within the Fountain Creek watershed, 2,254 acres of land could be converted into a reservoir if the full pool elevation was at 629 feet. All of this area is presently zoned A-2, Rural Residential District. Of this acreage, 42.6 percent of the land use is presently in agricultural use and 34.4 percent is forest land (Table 17). Wetlands occupy 10.1 percent and shrub/brush land another 8.2 percent of the area. Two cemeteries (Harris Cemetery and Lancaster Cemetery) are located on the perimeter of the reservoir and three others are located within 500 feet of the full pool elevation (Atkinson Cemetery, Pleasant Mount Cemetery, and Bethany Cemetery). State Highways 50 and 373 intersect the reservoir at several places, and a variety of other roads traverse the reservoir area (including Moore Lane, Old Highway 50, Vaughn Road, Bryant Road, and Seavy Hight Road). A Southern Railroad line extends through a portion of the reservoir area at a point west of the Glendale Community. A transmission line connecting to a substation southeast of Columbia travels along the northeastern perimeter and intersects the northern part of the possible reservoir area.

Of the 2,254 acres which might be included in a Fountain Creek reservoir, 1,272 acres (56.4 percent) are prime farmland soils (Table 17). Of the 1,272 acres of prime farmland, 53.4 percent is presently in agricultural use, forest grows on 25 percent of the area, 11.2 percent is in wetlands, 6.1 percent in shrub and brush land, and 4.3 percent is in other land uses. In this area, the most prevalent prime farmland soils are Huntington silt loam, phosphatic phase (see Section 4.2). Other prime farmland soils in this potential reservoir area are Armour silt loam, eroded gently sloping terrace phase; Captina silt loam; Egam silty clay loam; Etowah silt loam; Hagerstown silt loam; Lindside silt loam; and Maury silt loam.

Other Alternatives

Each of the other alternatives would affect much smaller tracts of land, typically only in narrow corridors. The downstream water supply alternative would involve construction of a pipeline extending approximately 13 miles along State Highway 50 between Williamsport and Columbia. Approximately 70 percent of the area bordering that highway is agricultural land, 27 percent is forestland, and 3 percent is residential. The Tims Ford pipeline alternative would include construction of a pipeline (approximately 20 miles long) from Tims Ford Reservoir, in Moore County, to discharge into the Duck River near Shelbyville, in Bedford County. The pipeline would be constructed along

Table 17. Present total land use and present use of prime farmland soils within the possible impoundment area of a Fountain Creek reservoir (at elevation 629).

Land Use *	All Land *		Prime Farmland **	
	Acres	Percent	Acres	Percent
Agriculture	961	42.6	679	53.4
Forestland	776	34.4	318	25.0
Wetlands	227	10.1	142	11.2
Shrub/Brush	186	8.2	77	6.1
Water Bodies/Streams	79	3.5		
Residential	2	0.1		
Industrial/Commercial/ Other Built-Up Areas	23	1.0		
Other Use			55	4.3
Totals	2,254	100.0	1,272	100.0

* - TVA unpublished data
** - USDA, Soil Survey of Maury County, Tennessee, 1959

existing State Highway 82 and other road rights of way. State Highway 82 is bordered by about 75 percent agricultural land and about 25 percent residential land use. The majority of the land use bordering the other possible roads is forest land.

The raise Normandy pool alternative is somewhat different in that it would affect a band of land all around Normandy Reservoir located in Bedford and Coffee counties. This land is managed as a natural resource area and includes two camping areas (Cedar Point and Barton Springs) and several boat launching ramps (see Section 4.11). Two roads traverse the reservoir: Hiles Road and Mountview Road.

None of the potential pipeline corridors along state highways or other road rights of way would be classified as prime farmland. However, any non-highway pipeline easements, locations for water intakes, and locations for new water treatment plants could contain some prime farmland. The extent of prime farmland along these corridors has not been estimated because no specific sites or routes have been identified. About 25 percent of the soil on the perimeter of the Normandy Reservoir is classified as prime farmland (USDA,1999).

4.11 VISUAL CHARACTER, RECREATION, AND NATURAL AREAS

Visual Character

The physical, biological, and cultural features of an area combine to make the visual landscape character both identifiable and unique. Scenic integrity indicates the degree of unity or wholeness of the visual character. Where and how the landscape is viewed will affect the more subjective aspect of its aesthetic quality and sense of place. Views of a landscape are described in terms of what is seen in foreground, middleground, and background distances. In the foreground, an area within one half-mile of the observer, details of objects are easily distinguished in the landscape. In the middleground, normally between a mile and four miles from the observer, objects may be distinguishable but their details are weak and they tend to merge into larger patterns. Details and colors of objects in the background, the distant part of the landscape, are not normally discernible unless they are especially large and standing alone. The impressions of an area's visual character can have a significant influence on how it is appreciated, protected, and used.

The visual character of the upper Duck River watershed is typical of many central Tennessee river valleys. Much of the river corridor is bordered by tall bluffs and steep, rocky, forested banks. The land away from the river consists primarily of gently rolling topography and relatively shallow, gently flowing tributary streams. The countryside is a varied mix of woodland, open pastures, crop land, and mostly small communities, with little industry and relatively few major highways. Together, the natural and cultural elements in this area provide attractive scenic variety and form a relatively harmonious rural landscape.

The four action alternatives considered in this evaluation would each affect only part of the study area. The following paragraphs describe the present visual setting in which these alternatives would be placed.

Fountain Creek Reservoir Area

The possible 2200-acre reservoir would occupy part of a bottomland drainway averaging about 2000 feet wide, with a meandering stream, several smaller tributaries, and little elevation change. Within this area, open land originally bought for Columbia reservoir is mostly covered with recent-growth brush and trees. The remainder of the area is a mix of pasture and woodland. A few old roads remain, some of which are blocked to traffic and the bridges have been

removed. The reservoir area is surrounded by a gently rolling rural landscape consisting of woodlands, pastures, and sparse residential development. The elevation difference averages about 140 feet. Scenic integrity is moderately high. The natural and cultural elements together provide harmony, coherence, and scenic attractiveness in this area of rural countryside.

Homes are clustered on the higher elevations around the Scribners, Fountain Heights, and Crews Hill areas. The valley floor can be seen in the near foreground by these residents, as well as from a few farms. Motorists see the area in the foreground from local roads and Brush Creek Road bridge. They also see this area in both the foreground and middleground from the Highway 50 bridge. Traffic maps prepared by the Tennessee Department of Transportation show an average of 9,100 vehicles per day on this portion of Highway 50 and about 240 vehicles per day on Brush Creek Road. The potential reservoir area is also seen in the immediate foreground by those using the land for recreational activities.

Downstream Water Intake Area

The potential pipeline corridor generally follows Highway 50 and some local roads which run through a primarily rural countryside. The topography is gently rolling with an elevation difference along the route of about 220 feet. The corridor also runs through a small area of urban and industrial development on the northwest side of Columbia. The route crosses several streams and the Duck River near Williamsport. This area includes pasture lands, occasional woodlands, light residential development, churches, schools, and some revegetated strip mine areas. A variety of homes, farms, and several small subdivisions are located along the highway and adjoining local roads. Scenic integrity is moderate. The natural and cultural elements together provide variety, scenic attractiveness, and visual harmony with few contrasting elements in this corridor of rural landscape.

Residents and motorists view the potential pipeline corridor in the immediate foreground and beyond. Traffic maps show an average of 4,430 vehicles per day on Highway 50 from Columbia to the Sawdust community, and 2,800 vehicles per day from Sawdust north to Williamsport. A Duck River crossing would be seen in the immediate foreground of those using the adjacent river section for recreation activities and, possibly, by motorists on the highway bridge.

Normandy Reservoir Area

The potential project area includes Normandy Reservoir and a band of the surrounding property, all owned by TVA. Most of the surrounding land is steeply sloping, with five percent or less sloping gently enough for comfortable human use. The elevation difference from the full pool reservoir to the ridgetops averages about 230 feet. About 80 percent of the shoreline is wooded. The back-lying rural landscape has similar steep slopes with gently rolling ridgetops. The lands include pastures, woodlands, sparse residential development, and a few farms. Residential growth is occurring, especially on ridgetops that have views of the reservoir. Scenic integrity is moderately high. The natural and cultural elements together provide variety, scenic attractiveness, and visual harmony around this rural reservoir.

The reservoir is seen in the foreground by residents located on ridgetops and back-lying slopes near the shoreline. The visiting public views the areas from TVA facilities at the dam reservation and other recreation areas on the reservoir. Motorists see the reservoir in the foreground from Riley Creek Road, Wards Chapel Road, Powers Bridge Road, and other local roads. Traffic maps show an average of 1,790 vehicles per day on Riley Creek Road. The reservoir shoreline is also seen in the foreground by those using the lake for recreation activities.

Tims Ford Pipeline Area

The potential pipeline corridor generally follows local roads from Tims Ford Reservoir to the intersection of State Routes 55 and 82, then follows Route 82 to the Duck River near Shelbyville. The possible intake areas are located on embayments with mostly wooded shoreline and very few residences. The pipeline corridor runs through rather hilly rural countryside from Tims Ford Reservoir to about the Flat Creek community, and more gentle topography from there to the Duck River. Elevation difference along the route is about 400 feet. The study route crosses several streams, and includes pastures, woodlands, light residential development, several churches, and a school. A variety of homes and farms are located along the roadways. Scenic integrity is moderate. The natural and cultural elements together provide variety, scenic attractiveness, and visual harmony within this corridor of rural landscape.

Residents and motorists along the route view the corridor in the immediate foreground and beyond. Traffic maps show 850 vehicles per day along Chestnut Ridge Road near the embayments, 1,800 vehicles per day south to

Highway 55, and over 3,100 vehicles per day on Highway 82 from Flat Creek to Shelbyville. Potential areas for the intake can be seen by motorists on local roads crossing near the head of the reservoir embayments. The discharge area near Shelbyville is seen by residents on both sides of the river and from the highway bridge. These terminal points of the corridor are also seen in the foreground of those using adjacent sections of Tims Ford Reservoir and the Duck River for recreation activities.

Recreation Activities

Local residents and people from surrounding counties enjoy many types of recreational activities within the upper Duck River watershed. Water-based recreation activities include fishing in several habitats and boating on both the streams and reservoirs. Land-based recreation includes hunting, camping, and other individual activities, as well as group activities in a wide variety of parks and other facilities.

On a scale ranging from unattractive, uninspiring, pretty, beautiful, and spectacular, Sehlinger and Lantz (1983) described the middle section of the Duck River as "pretty." The same authors rated the Elk River "mostly pretty with some beautiful spots;" the Buffalo River "mostly beautiful with some pretty spots;" the Harpeth River "beautiful in spots;" and Richland Creek is rated "pretty." This part of the Duck River has few obstructions and is an easy canoeing stream. The American Whitewater Association (AWA) would consider this to be a Class I River, meaning there is moving water with a few riffles and small waves with few or no obstructions (AWA, 1977).

Several improved access points help people enjoy recreational time on the river. DRDA and TWRA have developed a concrete boat ramp and parking area on the river at Iron Bridge Road. A similar facility has been discussed for a site at Carpenters Bridge. The Iron Bridge ramp is used as a bass boat access to that section of the river and as a staging area for local weekly bass tournaments. Other access points at Williamsport, Chickasaw Trace, Columbia, Leftwich Bridge, Lillard Mill, Hardison Mill, Henry Horton State Park, Shelbyville, Three Forks Bridge, Dement Bridge, Cortners Mill, and Normandy Dam are used for canoeing and float fishing in those river sections. Carpenters Bridge has historically been used as a take out point for the eight miles of river downstream from Hardison Mill, the section which has been the most popular for canoeing.

TWRA maintains a year-round trout fishery in the Duck River just downstream from Normandy Dam by stocking trout from March through December. Stocking is concentrated near the dam, but the fishery extends to approximately Three Forks Bridge, eight miles downstream. A warmwater fishery for black bass (smallmouth bass, largemouth bass, spotted bass), sunfish (rock bass, bluegill, and crappie), and catfish develops several miles downstream from Normandy Dam, where the water temperatures return to normal, and continues throughout the remainder of the river. The warmwater sport fishery downstream from the Columbia City Dam also includes sauger and striped bass which migrate into that part of the river during their spawning season. Migrating redhorse and other sucker species also are caught throughout the Duck River by snag fishermen.

Normandy and Tims Ford reservoirs are popular water bodies for sport fishing. During 1996, an estimated 232,955 total hours were spent by fishermen at Normandy Reservoir (TWRA, 1997). Targeted species were primarily black bass, crappie, and catfish, although walleye/sauger and white bass were also sought. Tims Ford Reservoir supported over twice as much fishing pressure (509,571 hours) in 1996 as Normandy (TWRA 1997). In Tims Ford, the targeted species included black bass, striped or hybrid striped bass, and crappie, with lesser effort spent on walleye/sauger, sunfish, catfish, and white bass.

TVA's sport fishing index values indicate that Normandy Reservoir ranks among the best fishing lakes in the Tennessee and Cumberland River valleys. In 1998, Normandy ranked above average for largemouth bass, spotted bass, white bass, bluegill and channel catfish (TVA unpublished data). The index value for walleye/sauger fell to below average, and sample sizes for smallmouth bass and crappie were too small for a reliable calculation. Tims Ford Reservoir ranked above average for white bass and walleye/sauger and below average for largemouth and smallmouth bass, striped bass, bluegill and channel catfish. Small sample sizes for spotted bass and crappie precluded index calculations in those categories.

Hunting is the most identifiable form of land-based recreational activity in this project area. The public lands just east of Columbia and around Normandy Reservoir are fairly heavily used by people hunting for deer, turkey, rabbit, squirrel, and quail. Many private lands also are used during the hunting seasons. During 1998, over 8,800 deer and 1,000 turkeys were harvested in the 5-counties within this project area (TWRA unpublished data). Maury

County ranked eighth among Tennessee counties in total deer harvested during the 1998 season, and sixth during the 1997 season (TWRA unpublished data).

Several state and county recreational facilities exist within a 30-minute drive of the Columbia area, including five county parks west of Columbia. Maury County Park and Chickasaw Trace Park are the largest and most developed. Maury County Park is a 200-acre park serving both passive and active recreation needs. The park serves open space needs as well as picnicking, equestrian, various levels of league baseball, and Maury County Football Stadium. Chickasaw Trace Park is a large county park oriented toward family picnicking, open space, and river access.

Henry Horton State Park is located along the Duck River between Columbia and Shelbyville. This 1,140-acre park provides opportunities for camping, sport fishing, canoeing, and hiking. There is also a 72-room inn, a swimming pool, a championship golf course, and the only skeet and trap range in the Tennessee State Park system.

Near Shelbyville, TVA owns a small parcel of land where Highway 82 crosses Duck River that was acquired as a possible river access area. Although this site is presently undeveloped, TVA recently has received inquiries from Bedford County about proceeding to develop this access to the river.

Recreation facilities around Normandy Reservoir include two developed public campgrounds and a variety of other facilities. Barton Springs Campground includes 65 campsites with picnic tables and fire rings, three bathhouses with heated showers and flush toilets, a beach, a picnic pavilion and other picnic tables, and a boat ramp with a courtesy pier. Cedar Point Public Use Area has 50 campsites with picnic tables and fire rings, two bathhouses with heated showers and flush toilets, a picnic pavilion and 14 other picnic spaces, a beach, and a boat ramp. Four additional lake access areas, each with paved parking lots and boat ramps, exist on the dam reservation and at sites on Boyd's Branch, Ward's Chapel, and Powers Bridge. On the downstream side of the Normandy Dam Reservation is a public access area with paved parking and bank fishing facilities, as well as a canoe launch area. This access area is the upstream end of a 28-mile scenic floatway on the Duck River below the dam with public access areas at six locations.

Tims Ford State Park, located on the northern shore of Tims Ford Reservoir, contains approximately 1,680 acres, 20 cabins, 50 campsites with tables, grills, and electrical and water hookups. A lakeside picnic area has 50 individual tables and grills plus two picnic shelters with fireplaces, grills and numerous tables. The park, operated by TDEC, also includes a marina which provides equipment and supplies for boating and fishing, a boat launching ramp and dock, and rental boats. A double L-shaped swimming pool features a 12-foot diving pool, children's wading pool, bathhouse and concession stand. There are five miles of paved trails for hiking and cycling. An 18-hole golf course with pro-shop and driving range is expected to open soon.

Other public facilities located on Tims Ford Reservoir include two municipal parks (Winchester City Park and Estill Springs Park), Devils Step Campground, a swimming beach, and seven public boat launching facilities. Two commercial marinas on the reservoir provide boat storage, fuel, and boating supplies. There are several informal lake access areas and numerous informal recreation use areas.

Three wildlife management areas and two state scenic river segments are located within a one-hour drive of the Columbia area. Normandy State Wildlife Management Area is an approximately 750-acre area that is managed by TWRA for hunting and fishing. Located on Normandy Reservoir along Riley Creek, this wildlife management area provides a tract of relatively undeveloped shoreline that enhances the quality of the outdoor experience for lake users. Laurel Hill and Middle Tennessee State University Wildlife Management Areas are located somewhat further away in Lawrence and Hickman counties, respectively.

Natural Areas

Several identified natural areas occur in or near this part of the Duck River watershed. These areas have been recognized and, to various degrees, are being protected because they contain unique natural resources or scenic values. The following paragraphs describe each of these natural areas and their relationships to the possible action alternatives.

The **Duck River State Mollusk Sanctuary** includes all of the mainstem Duck River upstream to Normandy Dam and continuing into the headwaters. Mollusk sanctuaries are designated and protected by TWRA to aid in the conservation of native aquatic mollusks. Various sites and reaches along the Duck River could be affected by the action alternatives.

Jackson Falls Potential National Natural Landmark is located between Delk and Baker Bluffs along the Duck River near River Mile 102. The National Natural Landmark Program, administered by the National Park Service, was established in the 1970s and is intended to identify nationally significant examples of ecologically pristine or near-pristine landscapes. The program has been mostly inactive for several years, and many potentially qualifying sites such as Jackson Falls have not been formally designated as National Landmarks. Jackson Falls is formed where Jackson Branch flows through a small gorge-like valley. This waterfall is a classic example of stream piracy, a geologic phenomenon where the headwaters of one stream (Jackson Branch) capture a portion of another stream (unnamed stream) that is in close proximity. Jackson Falls is near the area that could be affected by the Downstream Water Intake Alternative.

The **Natchez Trace Parkway,** administered by the National Park Service, includes approximately 450 miles of historic and scenic highway. This parkway was established in 1938 to commemorate the original Natchez Trace, an old trail stretching 500 miles through the wilderness from Natchez, Mississippi, to Nashville, Tennessee. The original trace followed Native American trails and was used by boatmen, traders, and explorers returning to the eastern states after sailing down the Mississippi River. Later, the trace was used as a federal postal road and for troop movements during the War of 1812. Natural, cultural, and historic resources along the Trace are managed to provide quality recreation experiences for visitors. The Natchez Trace Parkway crosses the northwest portion of the area that could be affected by the Downstream Water Intake Alternative.

Columbia Glade Natural Area provides protection for several endemic plants, including at least one federally-listed endangered plant species. Columbia Glade, which at one time probably occupied more than 1,000 acres, presently covers approximately 327 acres. This property, part of the former Columbia Project lands, is now being managed jointly by TWRA, TDEC, and TVA. Columbia Glade lies along the northwestern edge of the area that could be affected by the Fountain Creek reservoir Alternative.

Normandy Fish Hatchery is a 205-acre facility managed by TWRA that is used primarily for the propagation of warmwater game fish. This facility produces fish that are stocked to support the increasingly-important sport fishing industry in Tennessee. The Normandy Fish Hatchery is located just

downstream from Normandy Dam, in an area that could be affected by the Raise Normandy Pool Level Alternative.

Short Springs State Natural Area is a 421-acre site that is managed jointly by the City of Tullahoma, Tullahoma Utilities Board, Friends of Short Springs, TDEC, and TVA. This natural area is significant from botanical, geological, and historical standpoints. An exceptional variety and abundance of wildflowers occurs on this site, including two Tennessee state-listed endangered plants. The geological features include a 60-foot high waterfall, several cascades, and numerous dripping springs and rock formations. Historically, the area has ties to many of the pioneering families of the region. Especially appreciated for its abundance of spring wildflowers, this natural area receives heavy year-round use by outdoor enthusiasts. Part of the Short Springs Natural Area lies along the existing shoreline on Normandy Reservoir, within the area that could be affected by the Raise Normandy Pool Level Alternative.

Old Stone Fort State Archaeological Area is a 2,000-year-old Native American site. The mounds and walls that were built on high ground where the Duck and Little Duck rivers flow together form an enclosure that measures 1.25 miles around. This site is believed to have been used as a ceremonial gathering place over a period of at least 500 years. The present State Archaeological Area, managed by TDEC, includes a 50-site campground, picnic area, visitor center, and a 9-hole golf course. The Old Stone Fork area harbors a diversity of topography, soils, plants, and animals and is a potential National Natural Landmark (see Jackson Falls area description, above). Old Stone Fort State Archaeological Area includes land just upstream from Normandy Reservoir and probably would not be affected by the Raise Normandy Pool Level Alternative.

Arnold Engineering and Development Center (AEDC) includes 39,000 acres of rich and diverse terrestrial and aquatic habitats. Approximately 88 percent of AEDC is largely undeveloped and provides habitat for at least 68 protected or rare plant and animal species. In addition, AEDC includes **Woods State Wildlife Management Area** which is managed by TWRA for large and small game and waterfowl hunting. Several federal, state, and private conservation organizations are working together to implement an ecosystem management plan for most of the AEDC lands. This area is located approximately four miles southeast of Normandy Reservoir, outside of the area that could be affected by either the Raise Normandy Pool Level or the Tims Ford Pipeline alternatives.

4.12 CULTURAL RESOURCES

The physical cultural resources of an area include archaeological sites, historic structures, and sites where historic events took place but where no remains of the event are still present. A great deal of cultural research has been conducted in this project area, in part associated with the completion of Normandy Reservoir and in preparation for the construction of Columbia Reservoir. Surveys and excavations in this region have identified a large number of cultural sites and have confirmed human existence in the area from the earliest known Native Americans through the present.

Archaeological Resources

Archaeological time periods are identified based on differences in the styles of the artifacts that remain and changes in housing and land use patterns that are thought to have taken place. In the Central Basin, cultural history is generally divided into four broad time periods: Paleo-Indian, Archaic, Woodland, and Mississippian. The Paleo-Indian period (12,000-8,000 B.C.) represents the first documented human occupation, a time when the area was dominated by highly mobile bands of hunter/gatherers. In the Archaic Period (8,000-1,000 B.C.), people lived at dispersed campsites in the uplands during the fall and winter but started to stay along streams during the spring and summer where they gathered food from the water and bottomlands, and began to take care of some types of useful plants. During the Woodland Period (1000 B.C.-A.D. 900), the people in this region lived in clusters of more permanent dwellings (typically located on the floodplains), made and used pottery, and began to rely on plants they grew. When Europeans first encountered Native Americans in this area, the end of the Mississippian Period (A.D. 900-1600), they saw organized societies that farmed corn and other crops while living in permanent settlements (typically located just above the floodplains).

The first Europeans started living in the Duck River Valley in the late 18th century and settled there in increasing numbers during the first half of the 19th century. Rather quickly, agriculture became an important part of the local economy, with cotton and tobacco the most important crops before the Civil War; however, grain and livestock replaced cotton in the late 19th century (Lightfoot, 1998). Mill sites located along the Duck River are associated with the increasing importance of grain crops.

During the Civil War, numerous skirmishes occurred in the upper Duck River watershed area but no major battles were fought there. Prior to and

immediately following the Civil War, African-Americans accounted for almost 50 percent of the population of Maury and surrounding counties (Jolley and Newman, 1982). In the late 19th and early 20th centuries, the African-American population in the area declined as people left for higher paying jobs in cities and to the north.

The Tennessee Division of Archaeology collects information from surveys and maintains files on archaeological sites all across Tennessee. These files indicate that 1,092 archaeological sites have been identified in the four counties involved in this project (Table 18). The relatively large number of sites reported from Maury and Coffee counties probably reflects the extensive amount of archaeological research conducted in those counties as parts of the Normandy and Columbia reservoir projects.

Table 18. Known prehistoric, historic, or multi-component sites in Tennessee counties that could be affected by one or more of the action alternatives. Entries in the table may not add up to the totals given for each county because of uncertainties about what exists at each site.

Time Periods	Maury County	Bedford County	Coffee County	Moore County
Paleo-Indian	30	2	19	5
Archaic	476	61	443	27
Woodland	294	44	239	22
Mississippian	27	2	4	2
Historic	61	34	29	1
Total Number of Sites	560	217	278	37

Historic Structures

Historic structures include standing buildings and other structures (such as bridges and dams) that are more than 50 years old and have significant historical associations. Systematic surveys of potential historic structures have been conducted in Maury, Bedford, and Moore counties (Steve Rogers, Tennessee Historical Commission, personal communication 1999). In 1987, a total of 3,133 historic structures was recorded in Maury County. A total of 690 historic structures has been recorded in Bedford County. Results of a 1979

survey in Moore County conducted by Middle Tennessee State University included 201 historic structures. No systematic survey of Coffee County has been undertaken; however, at least 15 historic structures are known to occur there.

Each of the four action alternatives would occur only in small parts of the general area covered by this evaluation. The following paragraphs focus on what is known about cultural resources in these specific areas.

Fountain Creek Reservoir Area

Most of the archaeological survey and testing work that was done as part of the Columbia Reservoir project in the 1970s and 1980s focused on the mainstem of the Duck River. In the Fountain Creek watershed, 68 prehistoric archaeological sites were found on 240 acres, approximately 15 percent of the total area (Dickson, 1976; Evans, 1972). Two historic structures on or eligible for listing on the National Register of Historic Places (the Giles Harris House and the lime kiln on Silver Creek) also are located in the part of the Fountain Creek watershed acquired to be part of Columbia Reservoir (Jolley and Newman, 1982). While this work might have identified the most important cultural sites in the watershed, the remainder of any area affected by this alternative would have to be surveyed to know the full extent of the archaeological and historical resources that are present.

Downstream Water Intake Area

No systematic survey of this potential project area has been conducted, in part because no specific intake site and no specific pipeline route have been identified. A large number of archaeological sites and historical structures are known to occur in Maury County, some of which are likely to occur along the Duck River and State Route 50. The specific area affected by this alternative would have to be surveyed to know the full extent of the archaeological and historical resources that are present.

Normandy Reservoir Area

Before Normandy Reservoir was completed, the University of Tennessee identified the archaeological and historical sites in the area (Faulkner and McCollough, 1973) and excavated sites that contained important archaeological resources (Faulkner and McCollough, 1977: 1978; and 1982). All of the structures that occurred on Normandy Project land were removed before the reservoir was filled. However, during a recent survey of 10 miles of Normandy Reservoir shoreline, 11 archaeological sites were found on relatively flat lands

in tributary hollows (John Cable, 1999, personal communication). The recent information suggests that some additional archaeological resources could occur in the area that would be affected by this alternative.

Tims Ford Pipeline Area

No systematic survey of this potential project area has been conducted, in part because no specific intake site and no specific pipeline route have been identified. Limited archaeological research was conducted in the area before Tims Ford Reservoir was completed (Faulkner, 1968). Additional archaeological surveys have been conducted as part of the TVA Shoreline Management Initiative and prior to development around the reservoir. In all, approximately 118 archaeological and historical sites have been recorded within the immediate Tims Ford Reservoir area. Twelve of these sites are located on the Hurricane Creek embayment and three are located on the Lost Creek embayment. A recent survey of approximately one-third of the TVA property on Lost Creek above the reservoir pool did not identify any additional prehistoric archaeological resources (DuVall, 1998). Away from Tims Ford Reservoir, the pipeline would likely have to cross several small streams and the Duck River floodplain. Flat areas along these streams are likely to have been suitable sites for prehistoric settlements. The specific area affected by this alternative would have to be surveyed to know the full extent of the archaeological and historical resources that are present.

4.13 SOCIOECONOMICS

The purpose of this project is to provide additional water to meet the future needs of the Maury/southern Williamson County Water Service Area. This Water Service Area includes virtually all of Maury County and the adjacent part of southern Williamson County (Figure 1). These two counties lie south of Davidson County (Nashville), and west to southwest of Rutherford County (Murfreesboro). Interstate 65 runs north and south through the eastern part of both Williamson and Maury counties. Interstate 840, now under construction, will pass through the southern part of Williamson County near the Maury County line and connect to Interstate 40 both east and west of Nashville. Interstate 840, which is now open from Interstate 40 east of Nashville to Interstate 24 near Murfreesboro, eventually will serve as a southern bypass for Nashville and provide much easier access east and west from the Columbia area. Given these various associations, an appropriate labor market area for this project would include both Maury and Williamson counties and all of the

counties adjacent to each of them. The nine counties in this Maury/southern Williamson County Labor Market Area are listed in Table 19.

According to the latest estimates prepared by the Bureau of the Census, the population of Maury County was 69,633 in 1998 (Table 19). If confirmed during the 2000 Census, this would amount to a 27 percent increase over the population counted in 1990. The 1998 population estimate for Williamson County (117,569) indicates that county grew even faster, experiencing a 45.1 percent increase since 1990. Rutherford County is the other county in the Maury/southern Williamson County Labor Market Area that added tremendously to its population, with an estimated increase of 40.0 percent since 1990. Overall, the state of Tennessee is estimated to have grown by 11.3 percent since 1990, while the national population increased by 8.7 percent. During the period from 1980 to 1990, the population in Maury County grew at a rate of 7.3 percent, while Williamson County grew at a rate of 39.4 percent. Growth in both counties was faster than Tennessee as a whole and the rate in Williamson County was much faster than the national average.

In 1997, the average income in Maury County ($19,304) was about 85 percent of the state average and 76 percent of the national average (Table 20). The average income in Williamson County was substantially higher ($33,760), at 149 percent of the state average and 134 percent of the national average. High average incomes in both Williamson and Davidson Counties raise the overall Maury/southern Williamson County Labor Market Area value above the state and national averages. During the period from 1979 to 1997, per capita income in Williamson County and the whole labor market area grew faster than in the state or the nation, while income in Maury County grew more slowly than both the state and national averages.

Table 19. Population statistics for counties in the Maury/southern Williamson County Labor Market Area . Data from U. S. Department of Commerce, Bureau of the Census

Counties in Labor Market Area:	1980	1990	1998	Percent Change 1980-90	Percent Change 1990-98
Davidson	477,811	510,786	533,967	6.9	4.5
Giles	24,625	25,741	28,925	4.5	12.4
Hickman	15,151	16,754	20,553	10.6	22.7
Lawrence	34,110	35,303	39,358	3.5	11.5
Lewis	9,700	9,247	10,868	- 4.7	17.5
Marshall	19,698	21,539	26,302	9.3	22.1
Maury	**51,095**	**54,812**	**69,633**	**7.3**	**27.0**
Rutherford	84,058	118,570	166,035	41.1	40.0
Williamson	**58,108**	**81,021**	**117,569**	**39.4**	**45.1**
Totals: Labor Market Areal	774,356	873,773	1,013,210	12.8	16.0
Tennessee	4,591,023	4,877,203	5,430,621	6.2	11.3
United States (X 1,000)	226,542	248,765	270,299	9.8	8.7

Table 20. Per Capita Personal Income (in 1997 dollars) for counties in the Maury/southern Williamson County Labor Market Area. Data from U. S. Department of Commerce, Bureau of Economic Analysis

Counties in Labor Market Area:	1979	1997	Percent Change 1979-1997
Davidson	19,870	30,723	54.6
Giles	15,849	19,526	23.2
Hickman	13,415	16,400	22.3
Lawrence	15,239	18,207	19.5
Lewis	10,366	14,627	41.1
Marshall	16,191	20,405	26.0
Maury	**16,399**	**19,304**	**17.7**
Rutherford	16,238	22,762	40.2
Williamson	**22,242**	**33,760**	**51.8**
Totals: Labor Market Area	18,753	27,472	46.5
Tennessee	16,508	22,699	37.5
United States (X 1,000)	20,158	25,288	25.4

The dominant sector of the economy in Maury County is manufacturing, primarily the automobile industry (Table 21). This dominance is particularly apparent with respect to income, where manufacturing accounts for 51.9 percent of the earnings total. The service, retail trade, and governmental sectors also account for important parts of the economy in Maury County.

In contrast, the economy of Williamson County is much more oriented toward the service sector, which accounts for 33.1 percent of employment and 36.6 percent of earnings in the county. Other important sectors in Williamson County include the financial and retail trade sectors.

Table 21. Employment and Earnings by Place of Work in Maury and Williamson counties, Tennessee in 1997. Data from U. S. Department of Commerce, Bureau of Economic Analysis

	Employment		**Earnings**	
Place of Work	Maury (Percent)	Williamson (Percent)	Maury (Percent)	Williamson (Percent)
Agriculture, Forestry, and Fishing	2,114 (5.0)	3,123 (4.6)	1,511 (0.1)	22,153 (1.1)
Mining	68 (0.2)	159 (0.2)	2,121 (0.1)	5,526 (0.3)
Construction	2,076 (4.9)	5,026 (7.3)	65,455 (4.6)	189,304 (9.3)
Manufacturing	11,733 (28.0)	5,645 (8.3)	735,529 (51.9)	186,912 (9.1)
Transportation and Public Utilities	1,595 (3.8)	1,873 (2.7)	65,064 (4.6)	95,543 (4.7)
Wholesale Trade	1,242 (3.0)	2,111 (3.1)	39,680 (2.8)	111,467 (5.4)
Retail Trade	5,897 (14.1)	11,625 (17.0)	91,935 (6.5)	220,223 (10.8)
Finance, Insurance, Real Estate	2,621 (6.2)	10,821 (15.8)	57,537 (4.1)	312,908 (15.3)
Services	9,457 (22.5)	22,648 (33.1)	209,959 (14.8)	748,205 (36.6)
Government	5,161 (12.3)	5,392 (7.9)	148,557 (10.5)	153,484 (7.5)
Total	41,964 (100.0)	68,423 (100.0)	1,417,348 (100.0)	2,045,725 (100.0)

Some of the action alternatives would involve construction and related activities in parts of counties outside of the Maury/southern Williamson County Labor Market Area. The counties that might be affected (Bedford, Coffee, Franklin, and Moore counties) are all located in the upstream part of the Duck River watershed or in the adjacent part of the Elk River watershed. Recent estimates about population, income, and employment statistics in these counties are presented in Table 22. Per capita personal income in each of these counties is below the average in the Maury/south Williamson County Labor Market Area. County population totals range from 5,196 in Moore County to 45,767 in Coffee County. Manufacturing accounts for almost 31 percent of jobs in Bedford County while employment in the other counties is predominantly service-oriented.

Table 22. Population, income, and employment information for other counties which might be affected by one or more of the action alternatives. Data from U.S. Department of Commerce, Bureau of the Census and Bureau of Economic Analysis

Measure (date of estimate)	Bedford County	Coffee County	Franklin County	Moore County
Population (1998)	34,533	45,767	37,465	5,196
Per Capita Personal Income (1997)	$19,130	$20,388	$18,420	$16,887
Employment (1997)	18,888	31,169	15,081	2,188
Manufacturing (%)	30.7	16.6	13.6	8.0
Trade (%)	15.7	20.3	18.3	n/a
Services (%)	17.8	36.1	31.6	n/a
Government (%)	11.9	10.8	11.6	32.8
Other (%)	24.0	16.2	24.9	n/a *

* - not available

4.14 ENVIRONMENTAL JUSTICE

Environmental justice refers primarily to ensuring that no segment of the population bears a disproportionate burden of health or environmental impacts of society's activities. Some studies suggest that poor, predominantly minority, populations are exposed disproportionately to adverse health and environmental impacts because of siting decisions for facilities with potential adverse effects. Other studies dispute these findings. Because of such

concerns, Executive Order No. 12898 directed certain federal agencies and requested others to consider environmental justice in environmental reviews.

The purpose of this project is to provide additional water to meet the future needs of the Maury/southern Williamson County Water Service Area. The part of Williamson County included in the study area is located in the southern parts of the Bethesda and Boston Census Divisions, as defined by the U. S. Bureau of the Census. The Bethesda Division includes the southeastern corner of the county. The Boston Division includes the remainder of southern Williamson County, including the part of the Town of Spring Hill that is located in Williamson County (most of the town is located in Maury County).

Information available from the 1990 Bureau of the Census indicates that both Maury and Williamson counties have smaller nonwhite populations and lower poverty rates than the state of Tennessee as a whole (Table 23). This is also true of the Bethesda and Boston Census divisions. Within Williamson County, the poverty rates in the Bethesda and Boston divisions are both higher than the county as a whole. The percent of nonwhite population in the Bethesda Division is higher than in the remainder of the county or in the Boston Division.

Table 23. Population in the Maury/southern Williamson County Water Service Area by race and poverty rates in 1990. Data from U.S. Department of Commerce, Bureau of the Census, Census of Population, 1990, File STF1A and File STF3A.

	Maury County Total	Williamson County			Tennessee Total (X 1,000)
		Total	Bethesda Division	Boston Division	
Population	54,812	81,021	4,252	3,945	4,877.2
White	45,868	74,903	3,792	3,784	4,048.3
Nonwhite	8,944	6,118	460	161	828.9
Percent Nonwhite	16.3	7.6	10.8	4.1	20.5
Percent below the poverty level	13.2	5.8	12.6	7.9	15.7

Some of the action alternatives would involve construction and related activities in parts of counties outside of the Maury/southern Williamson County Labor Market Area. The counties that might be affected (Bedford,

Coffee, Franklin, and Moore counties) are all located in the upstream part of the Duck River watershed or in the adjacent part of the Elk River watershed. Information about race and poverty rates in these counties from the 1990 Census is presented in Table 24. All four of these counties have smaller nonwhite populations than the state as a whole or in Maury County. Poverty rates are similar to those in the state as a whole, except for Moore County where the poverty rate is much lower than elsewhere in Tennessee.

Table 24. Population by race and poverty rates in 1990 for other counties which might be affected by one or more of the action alternatives. Data from U.S. Department of Commerce, Bureau of the Census, Census of Population, 1990, File STF1A and File STF3A.

	Bedford County	Coffee County	Franklin County	Moore County	Tennessee (X 1,000)
Population	30,411	40,339	34,725	4,721	4,877.2
White	27,117	38,233	32,501	4,536	4,048.3
Nonwhite	3,294	2,106	2,224	185	828.9
Percent Nonwhite	10.8	5.2	6.4	3.9	20.5
Percent below the poverty level	16.0	15.2	14.4	6.5	15.7